Electroacoustic Etudes for Clarinet and Pure Data

A Set of Etudes for Clarinet and Electronics for the Advancing Musician

by

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ABSTRACT

Electronic music, including the subgenre of interactive electronic music, has a century-old history and has established itself as a vital and important element of modern music cultures throughout the world. Acoustic musicians in the twenty-first century will be expected to perform and interact with electronic music. Currently, however, few resources are available to either the student or teacher to help advancing young musicians develop their skills working with electronic musical components. A considerable amount of electronic music is prohibitive due to cost, access to equipment, and degree of difficulty. Therefore, a set of works designed to specifically reduce these prohibitive costs seems necessary. As a performer/composer that plays clarinet and as an electronic musician that regularly utilizes the open-source programming software Pure Data (Pd), I feel my composing, performing, and technical experience uniquely positions me to create educational materials. For this project, I will compose/program a collection of electronic etudes for clarinet and electronics that: (1) utilizes Pd to provide electronic accompaniment, (2) is composed for clarinetists of varying experience levels, (3) and will be commercially available as electronic PDF and Pd files.

DEDICATION

This document is dedicated to my wife Sarah Bennett for her support, love, and brilliance during this difficult process. I could not have done this without her and I look forward to our continued journey.

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I would like to thank my colleagues at Paradise Valley Community College & Phoenix Conservatory of Music, my students, and all of the amazing musicians I am honored to work with on a daily basis in the Phoenix valley. I have made both my professional, artistic, and personal home in Phoenix and I find the unique and supportive community of musicians and artists to be both inspiring and fulfilling. I would especially like to thank Keith Kelly, Elizabeth Kennedy Bayer, Brett Reed, Chris Scinto, Doug Nottingham, Chris Stover, Kotoka Suzuki, Joshua Gardner, Robert Spring, and Barry Moon for their support, help, and experience.

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CHAPTER 1.0

INTRODUCTION

As humans continue to interface with technology and electronics so must the acoustic musician, who is already intimately dependent upon electronic technologies in recording studios, lighting of the performance stage, and even the metronome, which evolved from its mechanical origins to its delivery by any number of apps for smartphone devices. Today the prevalence of Digital Audio Workstations (DAWs) and Audio Interfaces, both affordable and portable, has allowed artists whose primary instrument is acoustic to produce complex electroacoustic compositions. Artists such as saxophonist Colin Stetson, bass clarinetist Michael Lowenstern, and cellist Zoë Keating utilize software and interface devices to create compositions that process on-the-spot acoustic performances ultimately utilized as layered lines and sounds that, thirty years ago, would only have been possible with a large ensemble or a pre-recorded tape. More importantly, electronic music is exciting and inspiring. And yet, when I would perform an electroacoustic piece or play a recording of electronic music for my students, I would get an inevitable question: “How can I do that?” Unfortunately, I found myself without a satisfactory answer and my students would often get discouraged.

The young musician usually encounters precious few resources to support experimenting with or learning about electroacoustic music. Furthermore, despite the drastic decrease in cost that such technology has seen over the past decade or more, less advantaged young musicians can find themselves priced out of the market; the equipment required to perform such music can still be unattainable. An affordable and easily attained software program, combined with a set of etudes for both pre-professional musicians and the pedagogues who teach them, therefore seems necessary. But how does one address the issue of cost? The answer lies within a

particularly fascinating, open-source software program called Pure Data (Pd,) written and programmed by Miller Puckette (b. 1959) and countless contributors.[1] By utilizing Pd to create interesting yet easy to operate patches combined with written material that the developing musician can perform, my hope is to create a set of etudes that can be realized on any number of electroacoustic setups.

This document details my creation of the *Electroacoustic Etudes*. The first section of this document will detail a selected list of electroacoustic works for clarinet with basic details of each work including composer, technical requirements, and electronic effects needed for performance. The next section will provide a selected bibliography of different published material used to help construct the etudes, including history, philosophy, composition, and programming literature, focusing on Miller Puckette's writings. Then I will provide an overview of the etudes that details the main components, patches, and performance requirements of each of the *Electroacoustic Etudes*. Following the etude overview is a list of recommended equipment that can be utilized to perform the etudes based on levels of cost and ease of use. The final section of this document includes the scores and program notes for each of the etudes.

[1] Miller Puckette, "Pure Data: Another Integrated Computer Music Environment," *Proceedings: Second Intercollege Computer Music Concerts* (Tachikawa: Kunitachi College of Music 1996), 37-41, Accessed March 3, 2020, https://puredata.info/docs/articles/puredata1997.

CHAPTER 2.0

A SELECTED LIST OF ELECTROACOUSTIC WORKS FOR CLARINET

2.1 Introduction

Music written for clarinet and electronics is varied and the library of available works is growing every day. Electroacoustic music for the clarinet can be broadly categorized in to four categories: (1) fixed media (with and without click), (2) interactive "fixed" media (triggered audio events), (3) interactive (live sound manipulation), and (4) a combination of the latter. Fixed media pieces utilize a backing track with which the musician plays during performance. The backing track can be either digital or analogue. In some cases, the composer will provide a "practice" version of the backing track that includes a "click track" metronome to help the performer learn the piece. Interactive "fixed" media includes audio events that are triggered either by the performer or by a technician. This would include pieces that either have fixed media to perform along with or special effects or other media to be toggled on and off at specific times. Interactive music that utilizes live sound manipulation usually requires the use of a computer or audio device to manipulate the sound during performance. Sometimes this interactive element is automated, but it may require a technician as well. Finally, a combination of all the above categories may be used. For ease, however, I will refer to works as either "Fixed" (category 1) or "Interactive" (categories 2, 3, & 4).

Table 2.1 lists several works for clarinet and electronics. Focus is placed on solo works for any type of clarinet including, but not limited to, soprano and bass clarinet. For ease of explanation, I will use several abbreviations regarding different types of electroacoustic equipment. These include: Public Address System (PA), Digital Audio Workstation (DAW), Audio Interface and/or Input/Output device/mixer/etc. (I/O), and Microphone (Mic). All of the listed examples benefit from using a DAW and/or computer

for modern performance so if not explicitly stated it should be implied. For any compositions listed as “Interactive,” it should be assumed that a fixed media element may be included as well. If a composition requires either Pure Data (Pd) or Max it will be assumed that you will need to have the program installed and have purchased a license (for Max only—Pd is open source and does not require a license) on a personal computer or laptop. For all “fixed” compositions, a device capable of playing the fixed media will be necessary for performance. Additional equipment is listed, if required, such as a pedal, amplifier, or a surround sound system that requires a spatialized array of speakers.

Many of the effects or techniques utilized in the etudes were inspired by this list. It is by no means a comprehensive or complete list of electroacoustic works for clarinet. For a more comprehensive list of works for clarinet and electronics (with a focus primarily on interactive works) see Rachel Yoder’s excellent website[2] where she provides a continuously updated spreadsheet dedicated to the topic for public view.[3] Many of the works on Yoder’s website will also be present here, so I hope that together these lists may complement each other and give the reader resource material for continuing their work within electroacoustic music. For even more resources the SEAMUS[4] database allows the reader to view any number of works for different orchestrations that includes both fixed and interactive media. Again, several of the works listed here were found using the SEAMUS database.

[2] Rachel Yoder, http://www.rachelyoderclarinet.com/research/interactive-music/.
[3] Alongside her website, she also has a fantastic dissertation about performance practice and electroacoustic music titled “Performance Practice of Interactive Music for Clarinet and Computer with an Examination of Five Works by American Composers.”
[4] Seamus Online, Accessed April 9, 2020, www.seamusonline.org.

2.2 Electroacoustic Works for Clarinet

Table 2.1. A Selected List of Electroacoustic Works for Clarinet

Composer	Title	Fixed/ Interactive	Technical Requirements
Arrell, Chris	*Altamira Evocations 1b*	Interactive	Max patch provided by the composer. Mic and Stereo PA for I/O. A pedal to trigger events or technician to run computer during performance required.
Bennett, Josh	*Mallard Phase*	Interactive	Mic and Stereo PA for I/O. Either a looping pedal and variable delay pedal or computer running Ableton. Ableton file available from the composer. If using Ableton, a pedal for triggering events is required.
Boots, Cornelius	*Invisible Orthodoxy*	Fixed	Stereo PA and Mic for amplification. Digital files and score available through corneliusboots.com.
Boulez, Pierre	*Dialogue de l'ombre double*	Interactive	Significant technical demands are required. An 8-loudspeaker PA system capable of mixing to the 8 separate channels is required. The performer is stationed in the center of the performance space with 6 loudspeakers surrounding the performer and audience. 1 loudspeaker should be placed away from both the performer and audience but still within audible range. The last speaker is placed below and pointed towards a grand piano with the sustain pedal permanently depressed. 2 mics are required. 1 mic to amplify the live clarinet and 1 mic to be placed over the piano. The loudspeaker below

Composer	Title	Fixed/ Interactive	Technical Requirements
			the piano will play sounds from the amplified clarinet so the mic above the piano can pick up the sympathetic resonance of the piano. Before the performance the soloist records the 2nd clarinet part (the composer specifically requests that the player record this part and not use another's pre-recording). This "tape" part will then be played through the surround PA system. As such, a sound technician will be required to be stationed at a mixer in order to facilitate fades through the PA system (though this could be pre-programmed using a DAW and I/O). Finally, lighting cues throughout the work will require a lighting engineer.
Davidovsky, Mario	*Synchronisms No. 12*	Fixed	Stereo PA and Mic for amplification. Score and CD files available from edition-peters.com.
Druckman, Jacob	*Animus III*	Interactive	Stereo PA and Mic for amplification and to send to I/O. Score requests a "feedback echo device" to create ambient echoes. A digital transfer of the tape part advised. Furthermore, some staging requirements are dictated in the score.
Gorokholinsky, Alexey (Kronodigger)	*Amphibian*	Fixed	Stereo PA and Mic for amplification. Score and media files available from kronodigger.bandcamp.com. Performance tracks are part of album/score purchase and can be downloaded to any device for performance purposes.

Composer	Title	Fixed/ Interactive	Technical Requirements
Gorokholinsky, Alexey (Kronodigger)	*I Like You*	Fixed	Stereo PA and Mic for amplification. Score and media files available from kronodigger.bandcamp.com. Performance tracks are part of album/score purchase and can be downloaded to any device for performance purposes.
Gorokholinsky, Alexey (Kronodigger)	*Into the Green*	Fixed	Stereo PA and Mic for amplification. Score and media files available from kronodigger.bandcamp.com. Performance tracks are part of album/score purchase and can be downloaded to any device for performance purposes.
Grabill, Elliott	*Darl for Clarinet and Live Electronics*	Interactive	Mic and Stereo PA for I/O. Unclear what kind of software or hardware is required. According to Grabiil's website (elliottgrabill.com), the piece is for "live electronics" but the composer does not list what those live electronics are.
Grabill, Elliott	*Pluto for B flat clarinet and live electronics*	Interactive	Mic and Stereo PA for I/O. Unclear what kind of software or hardware is required. According to Grabiil's website (elliottgrabill.com), the piece is for "live electronics" but the composer does not list what those live electronics are.
Hackbarth, Glenn	*Shadow Boxing*	Interactive	Mic and Stereo PA for I/O. Max patch provided by composer. A pedal for triggering events or a technician to run the patch during performance required.
Honour, Eric	*Quirk for Bass Clarinet and Computer*	Interactive	Max patch provided with download after purchase. Mic and Stereo PA for I/O. A pedal for triggering events or a

Composer	Title	Fixed/ Interactive	Technical Requirements
			technician to run the patch during performance required.
Hopkins, Christopher	*Touché*	Fixed	Stereo PA and 2 mics to amplify clarinets. According to the technical details on SEAMUS, software choice is up to the performers. However, the composer provides a simple Max patch to launch sound files.
Ingebritsen, Ryan	*Reprametrization 6: A Harmonious Concinnity*	Interactive	Significant technical requirements are intended for this work and a separate audio engineer is necessary. 8.2 surround amplification is required alongside live manipulation of a Max patch. At least 2 Mics are required for both amplification and live sound processing. Score and digital files available at ingebritsen.musicaneo.com.
Lippe, Cort	*Music for Clarinet and ISPW*	Interactive	Mic and Stereo PA for I/O. Max patch provided by composer. A pedal for triggering events or a technician to run the patch during performance required.
Lippe, Cort	*Music for Bass Clarinet and Tape*	Fixed	Stereo PA and device to play tracks for individual movements. Amplifying the bass clarinet is advisable for proper mixing. Digital files of the tracks available at the composer's website. A pedal to trigger the individual tracks may be used to start/stop audio through an I/O.
Lippe, Cort	*Trio for Clarinet and 2 computers*	Interactive	Max patches provided by the composer. Two computers required. A pedal to trigger events or technician to run the

Composer	Title	Fixed/ Interactive	Technical Requirements
			patch during performance. Stereo PA.
Lowenstern, Michael	*Ten Children Nos 1 - 10, Ariel's Hands, Drift, Trip, etc.*	Fixed	Stereo PA and mic for the instrument for proper mixing. Lowenstern offers many of his compositions on his website earspasm.com for a modest price. Each score comes with sheet music and a digital file for performance. *However* many of Lowenstern's works were conceived as interactive pieces. The author has been unsuccessful in acquiring the Max patches from the composer.
Lowenstern, Michael	*Ten Children No. 10*	Interactive	Stereo PA and mic for amplification and to send audio to I/O. This work can easily be recreated using a looping pedal or DAW with looping capabilities such as Ableton.
Merkowitz, Jennifer	*Les Crapauds De La Fontaine (The Toads From The Fountain)*	Fixed	Stereo PA and Mic for amplification. Digital files and score available from jbmcomposer.com.
Mobberly, James	*A Plurality of ONE*	Fixed	Stereo PA and mic for amplification. Tape part available from the composer.
Muhly, Nico	*It Goes Without Saying*	Fixed	Stereo PA and mic for amplification. Digital tracks provided with enclosed CD.
Muller, Jeremy	*Orbitals for Solo Clarinet and Web Audio*	Interactive	A mic and PA to amplify the clarinet may be necessary for proper balance depending on how many people are involved. The electronic part is played through web audio on the audience's smartphone devices. The audience will go to

Composer	Title	Fixed/ Interactive	Technical Requirements
			jeremymuller.com/orbitals while the performer will use jeremymuller.com/orbitals-clock to start and control the piece.
Olan, David	*Composition for Clarinet and Tape*	Fixed	Stereo PA and mic to amplify the clarinet for mixing purposes. CD with backing tracks available with purchase of the score from SheetMusicPlus.
Oxford, Josh	*Awwwww… for Clarinet and CD*	Fixed	Stereo PA and mic to amplify the clarinet for mixing purposes. CD with backing tracks available with purchase of the score from Potenza Music.
Oxford, Josh	*Funked up for Clarinet and CD*	Fixed	Stereo PA and mic to amplify the clarinet for mixing purposes. CD with backing tracks available with purchase of the score from Potenza Music.
Oxford, Josh	*Looping Etudes*	Interactive	Stereo PA and I/O to amplify clarinet and connect to a BOSS RC-30 Looping Station. Score available for purchase from Potenza Music.
Reich, Steve	*New York Counterpoint*	Fixed	Stereo PA and mic to amplify the clarinet for mixing purposes. CD with backing tracks available for rental from Boosey & Hawkes. However the composer instructs the performer to pre-record the other parts themselves. Therefore, access to a recording studio and/or recording equipment is required if the performer wishes to perform the piece this way.
Resonovich, Nikola	*Alt.Music.Ballistix*	Fixed	Stereo PA and mic for amplification. Individual tracks available with enclosed CD

Composer	Title	Fixed/ Interactive	Technical Requirements
			after purchase. Some way to trigger different tracks required, such as a pedal to start/stop tracks in a DAW.
Rowe, Robert	*Cigar Smoke*	Interactive	Mic and Stereo PA for I/O. C++ patch provided by the composer. A pedal for triggering events or technician required.
Smith, William O.	*SUMI-E for Clarinet and Computer Transformed Sounds*	Fixed	Stereo PA and mic for amplification. Tracks provided with enclosed CD after purchase. Some way to trigger individual tracks such as a pedal to start/stop tracks in a DAW.
Snowden, Stephen	*Shovelhead for Bass Clarinet + Electronics*	Interactive	Max patch provided on included CD with score purchase. Pedal to trigger events or technician to run the patch during performance. Stereo PA and mic to amplify the clarinet and send audio to I/O.
Subotnick, Morton	*Passages of the Beast*	Interactive	Stereo PA and mic to amplify the clarinet and send to I/O. Originally written for “ghost electronics” (a small device that mechanically changed parameters of sound effects over time). The device is no longer commercially available. A Max patch is available from the composer that requires a technician to control the patch through performance.
Topp, Brian	*Huayra-Tata for Clarinet and Electronics*	Interactive	Stereo PA and mic to amplify the clarinet and send to I/O. Computer running Max and an audio interface.

Composer	Title	Fixed/ Interactive	Technical Requirements
Wilson, Ollie	*ECHOES for Clarinet and Tape*	Fixed	Stereo PA and mic for mixing purposes. Tape part available with score, however it is in fact *tape*. So, a digital transfer ahead of time is advisable.

2.3 Conclusion

As can be seen, a considerable amount of work for clarinet and electronics is available. As both computers and computer software become cheaper and easier to use, the electroacoustic oeuvre for clarinet will likely only grow and become more extensive. Yet, very few pieces designed to prepare the student for playing electroacoustic work are available. On the above list the only piece designed to familiarize the performer with an electroacoustic style or piece of equipment is Josh Oxford's *Looping Etudes*. Further, several works on this list (e.g., Boulez's *Dialogue de l'ombre double*) require either considerable amounts of equipment, deep knowledge of how to operate difficult equipment, or both! This could be costly for the student. The equipment alone can be difficult to obtain or access. A deep understanding of electronic or live-sound equipment can also be difficult to obtain creating yet another prohibitive element. Lastly, the amount of time required to learn some of these works and their technical difficulty can discourage many young players.

Therefore, the *Electroacoustic Etudes* contained within this project seek to reduce some of the prohibitive aspects of electroacoustic music. By creating works with an open-source software program, the student will not need to purchase an expensive software license. By focusing each etude on a singular electroacoustic concept such as distortion, delays, loops, or fixed media, the works can be more manageable and easier

to realize. Allowing the performer to use a home computer or laptop as the main piece of equipment, the student will not need to invest in a significant amount of gear or devices unless desired. By keeping the pieces relatively short, the performer can realize each piece with less of a time commitment as compared to some electroacoustic works. In short, rather than creating prohibitive works that may discourage the advancing student, the *Electroacoustic Etudes* are designed to encourage the advancing student to participate in the exciting and radically fulfilling world of electronic music while still playing the clarinet as a main instrument.

CHAPTER 3.0

A SELECTED BIBLIOGRAPHY OF ELECTRONIC/ELECTROACOUSTIC HISTORY/THEORY/COMPOSITIONAL TECHNIQUE

3.1 Introduction

In preparing to compose the *Electroacoustic Etudes*, I utilized several written sources for both inspiration, instruction, and research. Electronic music (and particularly interactive computer music) may be a relatively new style of music compared to some other styles, but a considerable wealth of information and literature is still dedicated to the theory and practice of electroacoustic music. It seems appropriate, then, to have at least a cursory knowledge of the history of electronic music, an understanding of the philosophy and ideas behind electronic music, and texts dedicated to the theory of composing interactive computer music. It would also be necessary to focus on the literature, writing, and ideas of Miller Puckette since he programmed and designed the main software of this project: Pure Data. While several different kinds of software and devices can be used to create electronic music, I feel that Pure Data is a singular achievement due to its creative potential and open source architecture. And so, this selected bibliography will look into the above-mentioned components of electronic music with a particular focus on the writings of Miller Puckette.

3.2 Selected Histories of Electronic Music

Since interactive electroacoustic computer music is a style of electronic music, a cursory understanding of the history of electronic music is necessary. The texts in this section are not an extensive view on music history but instead a selected set of history texts that focus specifically on electronic music. While electronic music is a relatively new style of music, you can still find many sources that detail the early and recent advancements in electronic music. One of the earliest attempts to historicize electronic

music was edited by Jon Appleton and Ronald Perera in 1975. *The Development and Practice of Electronic Music* includes several short articles written by authors including Otto Luening, Gordan Mumma, John E. Rogers, and others. Before the opening chapter, "Origins," written by Otto Luening, the editors make an important note that "Each chapter in this book represents a fragment of a more comprehensive history that could be written a hundred years from now."[5] The book, however, does provide a good (if brief) description not only of the history of electronic music but the techniques and terms that electronic musicians utilize. John E. Rogers's chapter, "The Uses of Digital Computers in Electronic Music Generation," is particularly noteworthy given the year the book was written.[6]

Until recently, most discussion regarding the history of electronic music was included in histories detailing either the second half of the twentieth century or as a part of experimental music. Thomas B. Holmes's book, titled *Electronic & Experimental Music*, provides a more in-depth history and discussion of electronic music, including a separation of three distinct types of electronic music: Purely Electronic Music, Electroacoustic Music, and Tape Composition.[7] Curiously, Holmes reserves the discussion of experimental music for a later chapter despite admitting that avant-garde music predates electronic music.[8] Arguably, the biggest difference between Holmes and Appleton/Perera is that Holmes dedicates a chapter to the technological development of electronic music. In a similar approach to Holmes, authors Elliott Schwartz and Daniel

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[5] John H. Appleton & Ronald C. Perera, *The Development and Practice of Electronic Music* (Englewood Cliffs: Prentice-Hall, 1975), 1.
[6] Otto Luening, "Origins," *The Development and Practice of Electronic Music,* edited by Jon H. Appleton and Ronald C. Perera (Englewood Cliffs: Prentice-Hall, 1975), 1-21.
[7] Thomas B. Holmes, *Electronic and Experimental Music* (New York: Charles Scribner's Sons, 1985), 4-8.
[8] Ibid., 107.

Godfrey include electronic music as a part of their book *Music Since 1945: Issues, Materials, and Literature*. Here Schwartz and Godfrey split electronic music into two sections beginning with the eighth chapter, "The Electronic Revolution I: Tape Composition and Early Synthesizers,"[9] and the seventeenth chapter, "The Electronic Revolution II: Computers and Digital Systems."[10] Both of the above mentioned books also provide some very helpful discographies at the end of each work.[11]

The most comprehensive history of electronic music to date was written by Peter Manning in 2004. *Electronic and Computer Music* begins with the origins of electronic music in the avant-garde before 1945, traces the development of electronic music (both technologically and artistically), and gives a thorough description of some modern technologies, such as Digital Audio, Musical Instrument Digital Interfaces (MIDI), and Signal Processing. The eighteenth chapter, "Personal Computers and Sound Processing," is especially important to my work as Manning describes the development of the DAW and how both the technology and software became stable enough before the end of the twentieth century to allow the home user to use a personal computer to create a studio capable of recording, playing back, and manipulating sounds.[12] Manning's thorough text presents a well-rounded and technology-based discussion of the history of electronic music.

Some other histories regarding electronic music worth mentioning include Elizabeth Hinkle-Turner's *Women Composers and Music Technology in the United*

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[9] Elliott Schwartz and Daniel Godfrey, *Music Since 1945: Issues, Materials, and Literature* (New York: Schirmer Books, 1993), 107.
[10] Ibid., 342.
[11] For a comprehensive discography of electronic works up to 1968 see Hugh Davies, *Répertoire International des Musiques Electroacoustiques International Music Catalog* (Cambridge: MIT Press, 1968).
[12] Peter Manning, *Electronic and Computer Music* (New York: Oxford University Press, 2004), 347-360.

States: Crossing the Line. Hinkle-Turner's work attempts to cover in greater detail the innovations and contributions of female composers and innovators, such as Annea Lockwood, Pauline Oliveros, and Laurie Spiegel. Lesser known innovators such as Joan Miller, who was an acoustician and mathematician at Bell Labs working with Max Matthews to develop early computer music languages, are also discussed.[13] A recent development in electronic music history is the appearance of generalized histories on the internet. As recently as late October 2016, Ableton[14] published a series of histories titled "A Brief History of The Studio as An Instrument." The first part of the series dedicates the narrative to three very important innovators: Pierre Schaeffer, Pierre Henry, and the often ignored Daphne Oram.[15] While these histories are not scholarly (one should note the lack of cited sources), the information is still vital and, more importantly, these histories often include YouTube links to recordings of important works and tend to have a much more open attitude when it comes to the inclusion of women, people of color, and popular music as a part of electronic music history.[16]

3.3 Understanding the Directions of Electronic Music

To understand how electronic music has developed, and the many possible directions of its future, we need to understand the thinking and philosophy of the experimental electronic music innovators. While not an electronic composer, the Italian Futurist Luigi Russolo greatly affected twentieth century composition with his article "The Art of Noises: Futurist Manifesto," collected and translated by Barclay Brown in *The Art*

[13] Elizabeth Hinkle-Turner, *Women Composers and Music Technology in the United States: Crossing the Line* (Burlington: Ashgate), 38-41.
[14] Ableton, www.ableton.com.
[15] "A Brief History of the Studio as An Instrument: Part 1 - Early Reflections," last modified October 25, 2016, https://www.ableton.com/en/blog/studio-as-an-instrument-part-1/
[16] Note: the information in this three-part series is also publicly available and not restricted behind a paywall.

of Noises. In Russolo's manifesto, he claims the industrial revolution logically calls for sounds and noises to be utilized as music and "This evolution of music is comparable to the multiplication of machines, which everywhere collaborate with man."[17] Russolo would go on to create mechanical instruments with the purpose of creating specific noises.[18] Meanwhile, Edgard Verèse theorized as early as 1939 that a musical machine would be able to produce new sounds liberated from, "…the arbitrary, paralyzing tempered system…"[19] In both cases, there is a palpable desire to not only find new ways of creating music, but to discover, utilize, and create sounds beyond the instruments available at the time—an attitude that persists in electronic music to this day.

Another collection of important discussions regarding electronic music is *Stockhausen on Music*, a collection of lectures and interviews by or with Karlheinz Stockhausen compiled by Robin Maconie. In "Four Criteria of Electronic Music," Stockhausen discusses how electronic music should be both created and analyzed. The four criteria outlined by Stockhausen are: The Unified Time Structuring, The Splitting of the Sound, The Multi-Layered Spatial Composition, and The Equality of Tone and Noise.[20] In his discussion regarding tone and noise, Stockhausen argues that "If I sing a melody of consonants now, people would say it isn't music: we have no tradition of music composed in these sounds, and no notation for it. There you see how narrow our concept of music is, from having excluded consonants, then noises."[21] Stockhausen would later expand these ideas in his 1964 composition *Mikrophonie I* for four

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[17] Luigi Russolo, "The Art of Noises: Futurist Manifesto" *The Art of Noises*, Translated by Barclay Brown (New York: Pendragon Press, 1986), 24.
[18] Peter Manning, *Electronic and Computer Music* (Cambridge: Oxford University Press 2004), 6.
[19] Edgard Varèse and Chou Wen-chung, "The Liberation of Sound," *Perspectives of New Music,* 5/1, (Autumn-Winter 1966), 12-14.
[20] Karlheinz Stockhausen, "Four Criteria of Electronic Music," *Stockhausen on Music*, Compiled by Robin Maconie (New York: Marion Boyars, 1989), 88-111.
[21] Ibid.

percussionists (with a single Tam-Tam) and live electronics; an early example of live electronics combined with an acoustic instrument performed live.[22]

R. Murray Schafer's *The Soundscape: The Tuning of the World* is another crucial work within the electronic music world. In the glossary of the text, Schafer defines the word "soundscape" as, "The sonic environment. Technically, any portion of the sonic environment regarded as a field for study. The term may refer to actual environments, or to abstract constructions such as music compositions and tape montages, particularly when considered as an environment."[23] The text is written with four subsections: Part One: First Soundscapes, Part Two: The Post-Industrial Soundscape, Part Three: Analysis, and Part Four: Toward Acoustic Design. In Part Three, the chapter "Notation" provides a deep insight into the possibility of three-dimensional acoustic imagery and how it can visually show the elements of music that we perceive yet have not (at the time) found a way to notate. As Schafer said, "I would not be dragging this point over so many paragraphs if I did not anticipate that we are on the threshold of a change."[24]

For further reading on the ideas, philosophies, and analytical perspectives of electronic music (and other modern avant-garde styles) there are several sources available. *The Music Machine* by Curtis Roads is a collection of articles from *The Computer Music Journal* through 1989. Roads's collection includes interviews and writings by many well-known composers and researchers, such as Max Matthews, Paul Lansky, Jean-Claude Risset, Jonathan Harvey, and many more. *The Music Machine* is a large and thorough resource for understanding the work and processes of early digital computer music. Thomas Licata's *Electroacoustic Music: Analytical Perspectives* is a

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[22] Karlheinz Stockhausen, *Mikrophonie I* (London: Universal Edition 1964).
[23] R. Murray Schafer, *The Soundscape: The Tuning of the World: Our Sonic Environment and the Tuning of the World* (Rochester: Destiny Books 1977), 274-275.
[24] Ibid., 128.

collection of theoretical analyses of several important works that include acoustic instruments or acoustic sound sources, such as Stockhausen's *Gesang der Jünglinge*, Risset's *Contours*, and Joji Yuasa's *A Study in White*. *Sonic Mosaics: Conversations with Composers* by Paul Steenhuisen also provides deep and sometimes personal accounts of composition and theory with many electronic music pioneers and contemporaries including R. Murray Schafer, Alexina Louie, John Oswald, and Hildegard Westerkamp.

3.4 Composing Electroacoustic Music Using Max/MSP and Pd

Composers and performers have several choices available to them for creating electronic music today. Two options that give the composer a great deal of control over the sonic environment they wish to create are Max/MSP (Max) and Pure Data, both written by Miller Puckette.[25] Both Max and Pd are graphical programming languages allowing the user to combine messages, objects, and numbers to generate and control digital sound processing. For a textbook that deals exclusively with programming in the Max language, Todd Winkler's *Composing Interactive Music: Techniques and Ideas Using Max* mainly deals with creating patches capable of interacting with live performers. The text provides several graphic examples that are both clear and useful, including the chapter titled "Interface Design" that discusses the creation of usable graphic interfaces.[26] For the more advanced user who wishes to start designing their own objects for either Max or Pd, Eric Lyon's *Designing Audio Objects for Max/MSP and Pd* also provides in depth discussion and helpful graphics.

[25] Miller Puckette no longer manages or programs Max/MSP choosing to focus, instead, on Pd.
[26] Todd Winkler, *Composing Interactive Music: Techniques and Ideas Using Max* (Cambridge: MIT Press 1998).

The above-mentioned texts are fantastic resources however they do suffer from two negative aspects: cost and assumption of knowledge. For Max your best option for learning the basics is to follow the built-in tutorials or to take a course teaching Max. For Pd, the beginning user has a surprising amount of resources available for learning the Pd programming language that are both free and easy to follow. One webpage that provides both an introduction to digital music and a set of helpful tutorials for creating working Pd patches is *pure-data* available at FLOSS Manuals; a website dedicated to creating user manuals for free and open-source software.[27] Available to read online or as a downloadable PDF *pure-data* features several tutorials that include graphic examples for the user to follow along with.[28] Johannes Kreidler's *Loadbang: Programming Electronic Music in Pure Data* is also available as an online book at www.pd-tutorial.com or can be purchased in print. Kreidler takes the user from beginning programming to more advanced sound synthesis while going into more depth regarding both music theory and acoustic theory throughout later chapters. Much like Floss Manuals, Kreidler provides graphic examples for creating working Pd patches related to the chapters.[29]

The most thorough and comprehensive text regarding electronic music and programming in Pd is *The Theory and Technique of Electronic Music* (2007) written by the programmer of Pd (and Max), Miller Puckette. Like the two textbooks mentioned above, *The Theory and Technique of Electronic Music* is available online at Puckette's website: http://msp.ucsd.edu/. Puckette's text is also available as a PDF download or in print from World Scientific Press. *The Theory and Technique of Electronic Music*

[27] Floss Manuals, *pure-data*, Accessed April 9, 2020, http://flossmanuals.net/pure-data/.
[28] Ibid.
[29] Johannes Kreidler, *Loadbang: Programming Electronic Music in Pd* (Freiburg: Wolke 2009), Accessed March 2, 2020, http://www.pd-tutorial.com/english/index.html.

thoroughly discusses the elements of electronic music, beginning with sinusoids, amplitude, and frequencies, and progressively adding more and more techniques and ideas often used in computer/electronic music, such as filters, spectral analysis/creation, automation, and more. Rather than creating a text that details how you can use Pd through a series of tutorials, Puckette wrote a text regarding the larger ideas of computer music that uses Pd. Throughout the work Puckette not only explains how sound modulation works both mathematically and theoretically, he also explains how to program a Pd patch that accomplishes sound modulation.[30] The dense mathematical text may deter some people but few other texts are available that so clearly document exactly what it is a computer musician is doing and how to do it.

3.5 The (Further) Writings of Miller Puckette

The Theory and Technique of Electronic Music is the culmination of Miller Puckette's years of experience, research, and performance. While researching and working at the Institut de Recherche et Coordination Acoustique/Musique (IRCAM), Puckette developed the graphic environment MAX (based on the work of Max Matthews) that would eventually become Max/MSP (and in more recent years simply Max). In 1986, Puckette's article "Interprocess Communication and Timing in Real-Time Computer Music Performance" describes the work and research he had been doing at IRCAM in developing Max and the effort to create a "real-time system." The power of Max, as Puckette explains, is "…its ability to specify more complicated actions from simpler ones."[31] The next evolution of his research at IRCAM was to create a graphic

[30] You can also access several video lectures from Puckette's 2011 Computer Music I course offered at UCSD at this address: http://msp.ucsd.edu/syllabi/171.11w/index.htm
[31] Miller Puckette, "Interprocess Communication and Timing in Real-Time Computer Music Performance," *ICMC Proceedings* (Ann Arbor: Michigan Publishing 1986): 43, Accessed November 6, 2016. ISSN: 2223-3881.

environment so programmers could create usable real-time systems using graphics instead of text-based code. Eventually he would refer to this updated version of the Max program as "The Patcher." Puckette describes this graphic environment as a tool "…for making real-time computer music, currently with MIDI-controllable synthesizers."[32] But why would Puckette take the time to create a graphic interface for computer music? Puckette explains his stance in his article "Something Digital" where he explains, "The computer is better used as an instrument. A unique one, to be sure; no violin has a programmable user interface."[33] At the end of "Something Digital," Puckette discusses the hardware and software necessities of creating a computer music workstation where he expresses an interesting desire for computers capable of running both graphics and networked file systems—something the personal computer would eventually be able to do![34]

Before he could continue to develop this graphical program, he would need to develop many different systems for processing specific elements especially if he wanted to create sounds via a computer and have the computer "understand" sounds coming in through a Digital Audio Converter (DAC). In Puckette's article "FTS: A Real-Time Monitor for Multiprocessor Music Synthesis," he details how using a message-passing system can create a Faster Than Sound (FTS) communication environment that multiple computer processors can understand.[35] FTS would eventually help solve the problem of creating a real-time (or near to real-time) Digital Sound Processing (DSP) system, but what about the other way around? In Puckette's article "Combining Event and Signal

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[32] Miller Puckette, "The Patcher," *ICMC Proceedings* (Ann Arbor: Michigan Publishing 1988): 420, Accessed November 6, 2016. ISSN: 2223-3881.
[33] Miller Puckette, "Something Digital," *Computer Music Journal* 15/4 (Winter 1991), 65.
[34] Ibid., 68
[35] Miller Puckette, "FTS: A Real-Time Monitor for Multiprocessor Music Synthesis," *Computer Music Journal* 15/3 (Fall 1991), 58-67.

Processing in the MAX Graphical Programming Environment," he describes how to utilize the "notein" object with a frequency to MIDI object to then control generative objects such as "cosine" to produce sound only when a certain pitch is performed by a live musician.[36] By utilizing signal processing, like in the previous example, you can create interactive computer music that responds to real-time performance rather than having the performer respond to fixed media like tape recordings.

Puckette's research into signal processing would lead to a research collaboration with composer Cort Lippe to create better programming for tracking a performer live as they play through a pre-determined score otherwise known as computer score following. In Puckette and Lippe's "Score Following in Practice," they begin by describing a short history of score following at IRCAM. The authors then describe various situations in which score following can fail and how to solve these problems without using signal processing or pitch detection.[37] Much like the previously mentioned article, Puckette and Lippe's "Getting the Acoustic Parameters from a Live Performance" also details ways to achieve score following. More importantly, however, they dedicate a subsection called "Why Live Performance?" where the authors observe, "Most musicians of all cultures spend a certain amount of time learning to play an instrument with an acceptable degree of technical accuracy. More importantly, musicians spend a large amount of time developing their ability to play expressively."[38] By focusing time and attention on

[36] Miller Puckette, "Combining Event and Signal Processing in the MAX Graphical Programming Environment," *Computer Music Journal* 15/3 (Fall 1991), 68-77.
[37] Miller Puckette & Cort Lippe, "Score Following in Practice," *ICMC Proceedings* (Ann Arbor: Michigan Publishing 1992): 182-184, Accessed November 6, 2016. ISSN: 2223-3881.
[38] Miller Puckette & Cort Lippe, "Getting the Acoustic Parameters From a Live Performance," *Proceedings of the International Conference for Musical Perception and Cognition*, (Liege: University of Liege, 1994) 63-65. Accessed November 6, 2016. http://msp.ucsd.edu/publications.html.

developing score following ability Puckette and Lippe devised a way to create ever-more expressive and interactive computer environments for electroacoustic musicians.

In May of 1997, Puckette announced a new computer music program at the Second Intercollege Computer Music Concerts that was to be an improvement on Max in the article "Pure Data: Another Integrated Computer Music Environment," where Puckette describes some of the technical differences between Max and the new musical graphic environment Pd. Specifically Puckette discusses using ideas from other programs developed at IRCAM (including Pluton & Animal), the design, digital sound processing (DSP), and implementation.[39] The next year, Puckette gave an update on Pd's abilities in his article "Pure Data: Recent Progress" at the Third Intercollege Computer Music Festival with updates specifically regarding remote connections and pitch tracking that utilizes new forms of spectral analysis for improved tracking.[40] By 1997, Pd was available for download and install as open-source software. In the previously mentioned online work *Loadbang,* Johannes Kreidler describes Pd as "…not commercial software; i.e., it was not developed by a corporation and is not for sale. Instead, it is 'open source': its source code can be viewed by anyone. This source code is also not the (patented) property of a corporation but is rather freely available to all."[41]

3.6 Conclusion

The musical artists of the twenty-first century face significant difficulties in today's world. Electronic pioneer and composer Barry Truax once asked and answered, "…will

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[39] Miller Puckette, "Pure Data: Another Integrated Computer Music Environment," *Proceedings: Second Intercollege Computer Music Concerts* (Tachikawa: Kunitachi College of Music 1996), 37-41, Accessed March 3, 2020, https://puredata.info/docs/articles/puredata1997.
[40] Miller Puckette, "Pure Data: Recent Progress," *Proceedings, Third Intercollege Computer Music Festival* (Tokyo: Keio University 1997), 1-4, Accessed March 3 2020, http://msp.ucsd.edu/publications.html.
[41] Johannes Kreidler, *Loadbang: Programming Electronic Music in Pd* (Freiburg: Wolke 2009), Accessed March 2, 2020, http://www.pd-tutorial.com/english/index.html.

the artistic impulse survive? Of course it will, because it is a human necessity. Will it flourish and be an active part of our culture - not likely."[42] Meanwhile, during a symposium at Dartmouth College, Miller Puckette (along with the panel of software programmers he was with) was asked by an audience member how the open-source paradigm may influence future music software programming. In response, Puckette answered, "I think it is certainly true that the open-source movement is a very powerful source toward higher-quality software, and I would turn the question around and ask if open-source music wouldn't also be a very good thing. If composers starting making [sic] music available in such a way that you could absolutely use it for anything, it would be amazing how fast the musical culture would then develop."[43] Either way, the future of music (especially as an acoustic musician) is uncertain. However, Miller Puckette has given us a free, open-source software with few limitations and innumerable possibilities. While Truax's cynical view may come true, I also happen to think that as long as musician/composer/programmers like Miller Puckette continue to make and provide their work, the artistic impulse will in fact survive, flourish, and possibly even evolve into ever more complex and interesting musical expressions.

[42] Barry Truax, "Electroacoustic Music and the Digital Future," *Circuit: musiques contemporaines* 13/1 (2002), Accessed September 27, 2016 DOI: 10.7202/902261ar.
[43] Eric Lyon, Max Matthews, James McCartney, David Zicarelli, Barry Vercoe, Gareth Loy, and Miller Puckette, "Dartmouth Symposium on the Future of Computer Music Software: A Panel Discussion," *Computer Music Journal* 26/4 (Winter 2002), 28.

CHAPTER 4.0

AN OVERVIEW OF THE ELECTROACOUSTIC ETUDES

4.1 Introduction

The etudes were composed to have a notated portion for the clarinetist to read, a Pd patch to produce the electronic parts, and program notes that describe the purpose of the etude and how to setup the patch for performance. The performance notes also include other information such as suggestions for practice and performance, further listening, and suggestions for either manipulating the patch or trying/experimenting with different settings to produce a different result. While the etudes are not numbered, I have arranged them progressively by complexity to the performer. What follows is an analysis of each etude in an order that makes the most sense to me[44]. Each analysis will include a description of the kind of techniques needed to perform, the range, what the player can expect the patch to do, and any other information that may be relevant.

4.2 "Moving Through Space/Time"

The first electroacoustic etude is "Moving Through Space/Time." This etude was composed in 4/4 time with a relatively slow tempo of quarter note equals 60 beats per minute (BPM). The lowest note played is an E3 and the highest note is an A5[45]. Eighth note triplet figures are the fastest notes in this etude, and several long passages require the performer to hold notes for long durations. While the dynamics do not go any louder than mezzo forte, several hairpin figures need attention since they are designed to engage with the electronics. Similarly, several accents and tenuto marks are important in order to manipulate the effects produced by the patch.

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[44] Though it should be noted that a performer does not *have* to play the pieces in this order! You are free to determine the order yourself.

[45] Note: These notes are written pitch for a B-flat soprano clarinet, which sounds a whole-step lower than written.

The patch itself (fig. 4.1) is relatively simple to manipulate though it may look complex. “Moving Through Space/Time” utilizes a filter delay patch that takes the acoustic sound of the clarinet and either boosts or reduces frequencies across the frequency spectrum and then plays those frequencies back at different delay times. Input and output controls are located on the left side of the patch while the filter controls are on the right side of the patch. The patch initiates each of the three filter delays, with each having slightly different settings determined by sine waves. Each filter delay also has a stereo Left/Right output so the delay produces a “ping pong” effect. The result is a long ambient wash of sound that interacts with the musician’s performance. The resultant soundscape is why both the dynamics and articulations in the score are so important—the spectral-like nature of the patch becomes more apparent as the performer’s dynamics increase and decrease and accents and tenutos highlight the delay possibilities of the sound.

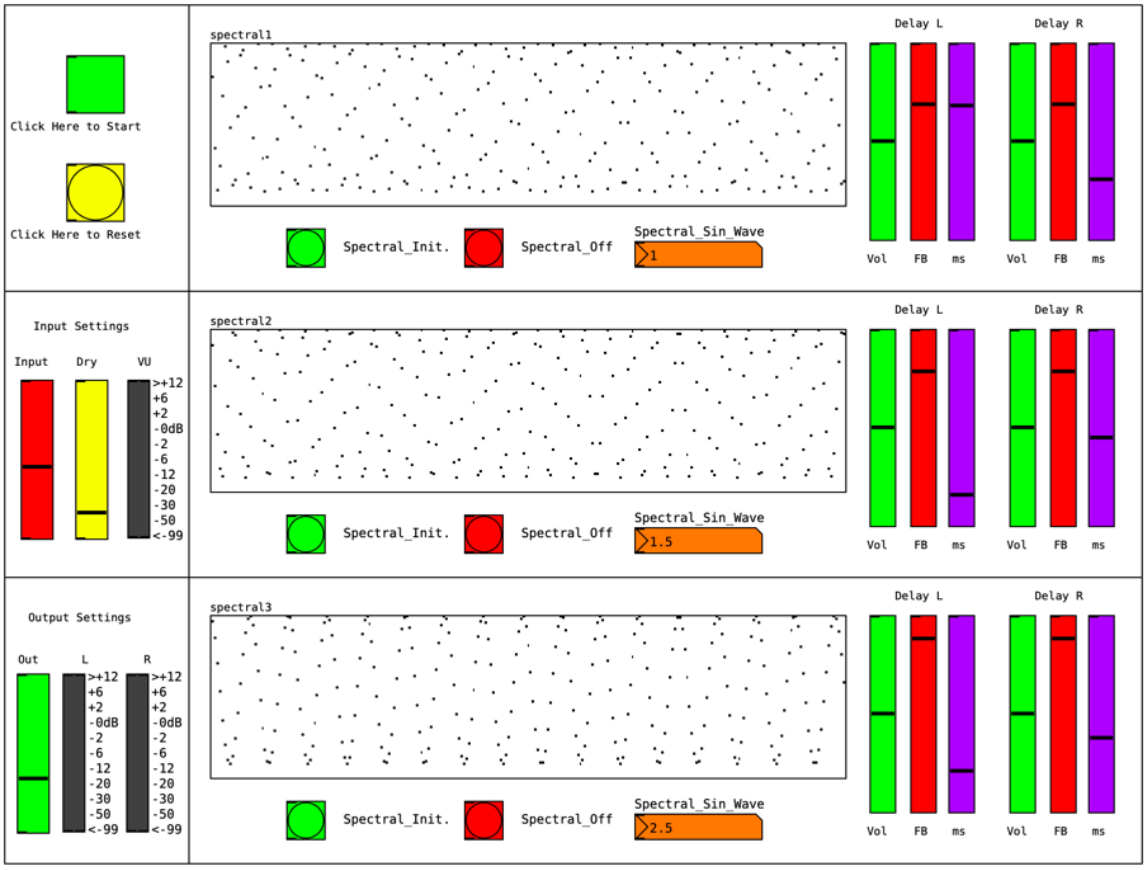


Figure 4.1. “Moving Through Space/Time”.

4.3 “System Delay”

“System Delay” utilizes a delay to create a rhythmic series of taps from the live sound of the clarinet. The tempo is listed as “Tempo ala Delay” since the tempo of the piece is determined by the echoes of the delay. The patch’s initial settings have each delay set to 250 milliseconds meaning that each delay tap comes back to the listener every quarter of a second. If we approach these taps as eighth notes that would be a tempo of 120 BPM. But the user is welcome to adjust this to their own desire. The range of this work is relatively constrained with the lowest note being a D4 and the highest note being a B-flat5. While the work begins in 4/4 time, there is a metric modulation where the eighth note tempo remains the same while changing first to 9/8 and then to 12/8.

Throughout the work, several repeats are played ad lib., with each repeat to be done *at least* four times, providing an improvisational element for the performer.

The patch for “System Delay” (fig. 4.2) is designed to be reminiscent of a guitar pedal such as the Boss DD-8 Digital Delay. Like most guitar pedals, the “On” button is in the center and near the bottom of the patch just above the “Reset” button. Above the “On” button are six faders that control the Input signal, the Left Delay milliseconds, the Left Delay feedback, the Right Delay milliseconds, the Right Delay feedback, and finally the master volume. Corresponding level meters are located below the faders. Much like “Moving Through Space/Time,” articulation should be focused on so the delay effect is properly heard. Unlike “Space/Time,” however, this delay is not filtered in any way. So, the delay taps should sound (more or less) just like the original input with each tap being exponentially quieter. As compared to “Space/Time,” the performer has less to manipulate but you can still do quite a bit. Playing with the feedback settings, in particular, can lead to some really intense levels of response via the patch. If you wanted, you could actually set the feedback levels to 100 and change the delay times to create a simple “looper” (more on this later).

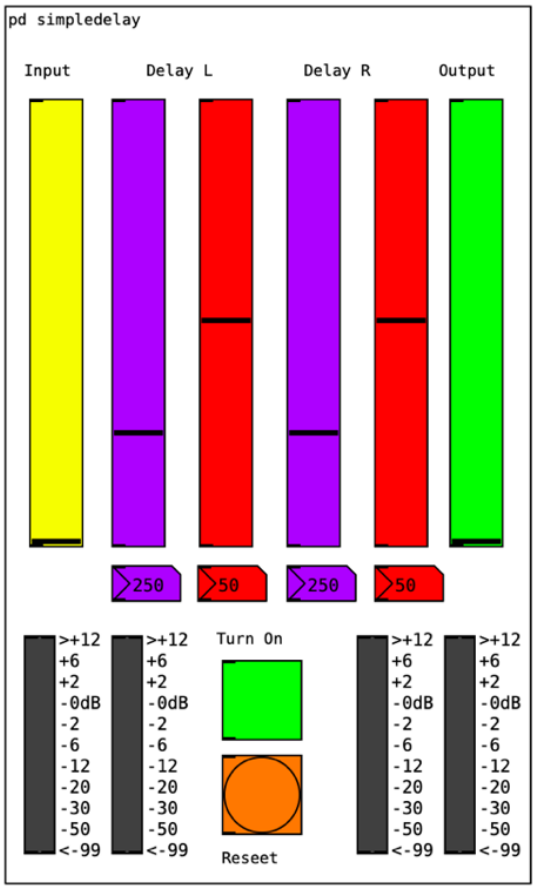


Figure 4.2. “System Delay”.

4.4 “Berg(sonian) Klang”

“Berg(sonian) Klang” is based on an interactive “Klangfarbe Machine” (or “Timbre Machine”) that analyzes the incoming signal to manipulate six oscillators and their frequencies based on multiples of the incoming frequency. The written music, meanwhile, is loosely based on several fragments from the first movement of Alban Berg’s *Vier Stücke für Klarinette und Klavier*.[46] The lowest note in the etude is a G3 while the highest note is a G-sharp6 (however this is optional for the player). Throughout

[46] The keen-eyed observer will also note that the title includes a reference to French philosopher Henri Bergson whose philosophy regarding time and free-will greatly inspired the author of this project.

the piece are several fermatas and articulation marks. While sixteenth notes are the quickest rhythms performed there are also several eighth note sextuplet figures. The piece begins and ends quietly but several dynamic (sometimes sudden and extreme) changes occur throughout. The dynamic changes play an important role in how the patch interacts with the performer, so they should be strictly observed in performance.

The patch (fig. 4.3) is interactive and for the most part does not require much set up by the performer. The “On” button in the upper left corner also toggles the “Klangfarbe On” button. Once toggled, you should notice that each of the “Klangs” (the individual oscillators) has a fader that begins to move of its own accord. The resultant effect should be an ever-changing timbre based on the performer’s original sound. At the bottom are four red faders. One controls the Input volume, one the unprocessed live sound or “Dry” output volume, the Klangfarbe volume, and the Main volume. The Klangfarbe volume, however, is actually controlled by the amplitude of the input. So, as you play it will react to your volume. This is why paying close attention to both the dynamics and the rests, breaks, and breath marks of the score is important.

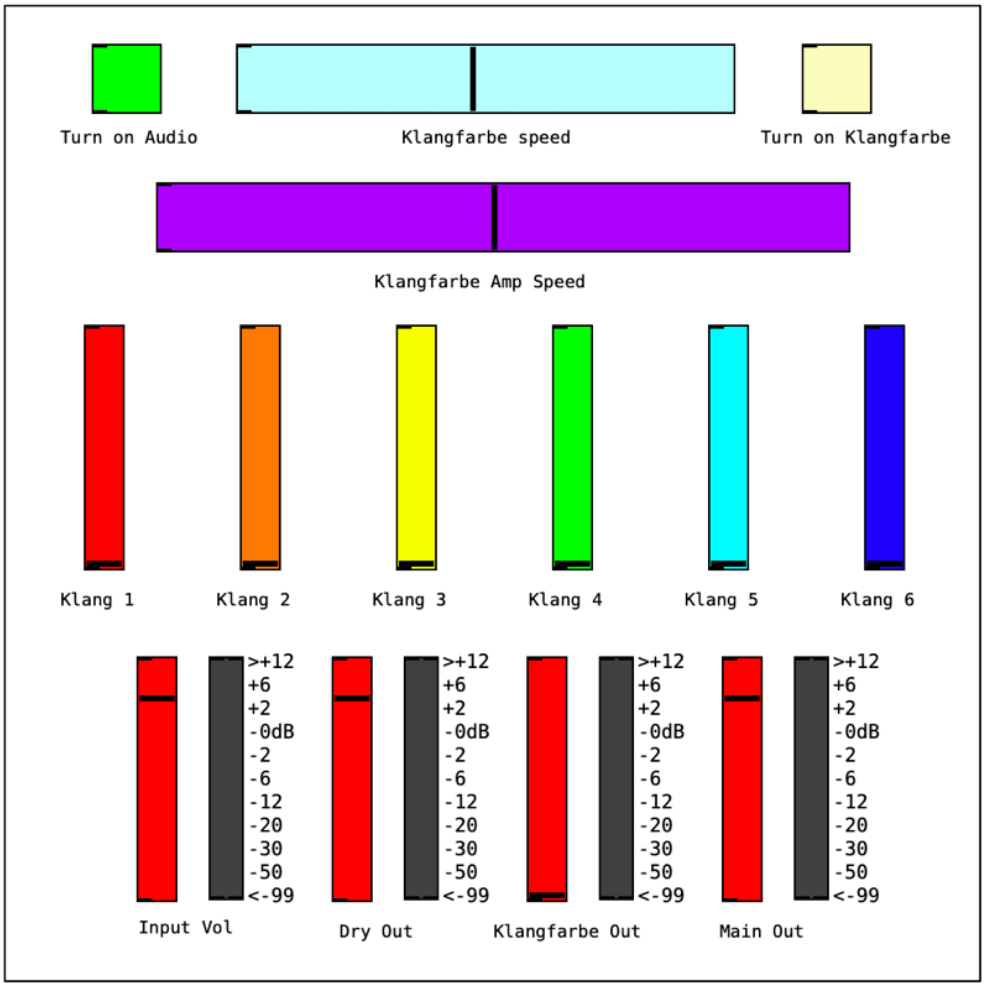


Figure 4.3. “Berg(sonian) Klang”.

4.5 “Distorted Reality”

“Distorted Reality” is another simple etude designed to introduce the student to distortion and takes considerable inspiration from Eddie Van Halen’s electric guitar solo in “Eruption” from Van Halen’s 1978 album *Van Halen*. The lowest note is an F3 and the highest is a D6. The piece begins in 4/4 time at 92 BPM but there are several time and tempo changes and rubato can be utilized throughout. The fastest written notes come in the second to last bar with a 32nd-note figure to the final D6. Several triplets, sixteenth, and sextuplet figures are also included. In measures 9, 18, and 35, pitch bends that can

be achieved by either covering holes with fingers, bending with the lip, voicing or a combination of all three. The jaw tremolo in measure 29 can be achieved by quickly opening and closing the jaw almost as if an exaggerated vibrato. In Van Halen's "Eruption," he quotes from a violin etude, *Etude No. 2*, by Rodolphe Kreutzer. Instead, I quote from the fourth etude of Cyrille Rose's *32 Studies for Clarinet* in measure 10.

The patch (fig. 4.4) is designed to be adjusted from left to right. On the left is a green button[47] to toggle audio off and on and a red button to reset the patch to initial settings. To the right of those two buttons is a slider that controls the input volume. Then two sliders that control the distortion clipping. To the right of that are two sliders that control a filter. To the right of that are three sliders controlling reverberation. And finally, one slider that controls the overall output. Of all the patches I designed for this project, this patch seems to benefit the most from experimenting with the settings. Unsurprisingly, the sound and timbre of the distorted effect is greatly affected by equipment. As a result I set the initial settings of the patch to a "middle of the road" setting that should work for most systems. Personally, I like to push the distortion and reverb faders to create a long, trailing distortion effect when using my Alto TS212a amplifier. Nonetheless, experimentation is encouraged.

[47] By now, it should be clear that a pattern has emerged regarding the patches. Audio will almost always be started with a green button that is fairly well marked. Input controls are on the left while output controls are on the right. I will continue to explain these controls in detail, but the pattern is consistent across all patches.

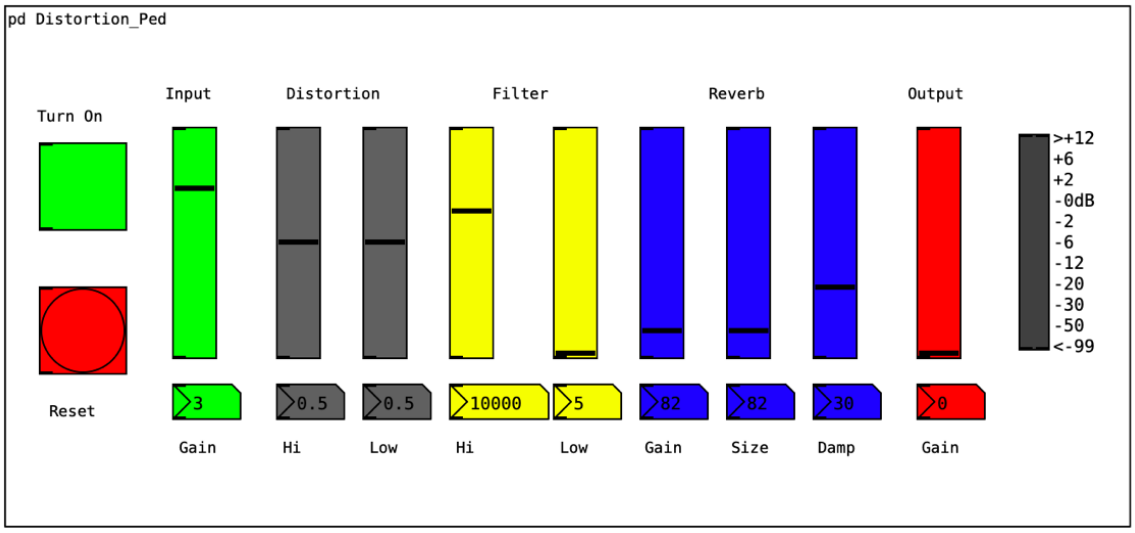


Figure 4.4. “Distorted Reality”.

4.6 “Loop Da Loop”

“Loop Da Loop” is a deceptively difficult etude because it requires precise timing. As the title suggests this, is a “looping” etude in which the patch automatically “loops” the live sound. The tempo for this etude is 84 BPM with the extra instruction to play “With Funk!” Since Funk is a style of music that emphasizes rhythmic accuracy and groove over melody the performer should try to focus on being radically in time while highlighting the syncopated nature of the written material.[48] The lowest note written is a G3 and the highest note is a D6. Several sixteenth and triplet figures occur throughout, though at 84 BPM, it should not be too challenging to play. Perhaps the most difficult elements are the syncopated rhythms and how those syncopated rhythms interact with other looped parts. Starting in measure 26 is an improvised solo section. I would recommend starting simple and just repeating the melody or even playing simple chord

[48] I recommend encouraging students to listen to Funk music to become better acquainted with the genre’s style.

tones. As the performer becomes more comfortable, they can begin experimenting with more melodic and rhythmic variety.

The patch (fig. 4.5) is designed with input/output controls on top and tempo/beat control on bottom. You begin by clicking on the green “Turn Audio On” button in the upper left-hand corner and adjusting input volume. A “mixer” section on the right-hand side is used to make any other adjustments to balance the “loops” and “live” sound. In the center of the patch is a button to toggle a “click track” on and off. By default, the patch sets the click to off. Turning the click on can be extremely helpful while practicing. The click is designed to sound like a hi-hat cymbal, so if needed, it can also be utilized during performance. After all of your input/output settings have been calibrated, you can then start the patch by clicking the green button marked “Click here to start looper.” You can adjust the speed of the metronome that controls the patch for practice purposes and use the visual “beat” indicator to help keep the musician in time. Since the patch includes a lot of visual indicators, you may consider setting the computer close to the sheet music or even memorizing the piece so you can focus on the patch instead of the sheet music. Either way, you will need to develop your timing considerably in order to perform with accuracy. The computer will not follow you, so you have to follow it!

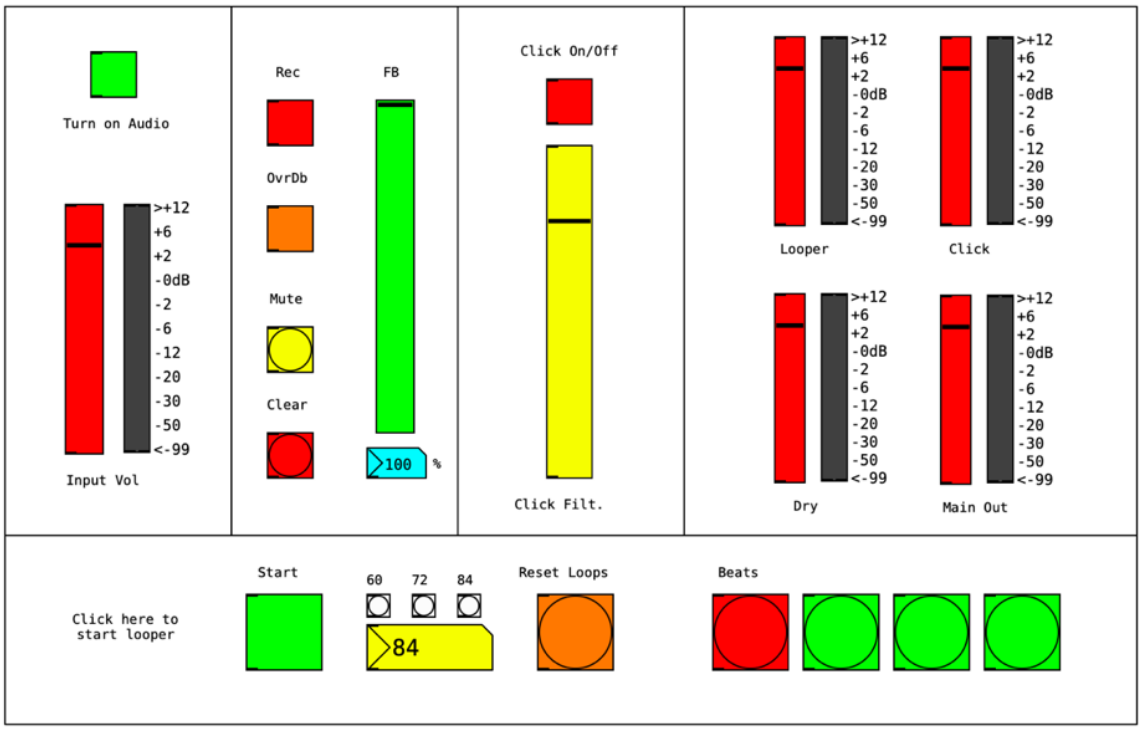


Figure 4.5. “Loop Da Loop”.

4.7 “Recurrence”

“Recurrence” also utilizes looping, however, using two separate loopers congruently. The lowest note of the work is an E3 while the highest written note is a B5. However, several improvised sections allow the perform to play in any octave. The work opens at 40 BPM with rubato. Sustained tones are utilized throughout, including figures of undetermined length because they are improvised. At measure 14 is a tempo change to 60 BPM where sixteenth note “pulses” (à la Steve Reich) are performed with dynamic swells from niente to mezzo forte. Instructions are given to the performer throughout the score to manipulate the patch during performance. Several “boxed-in” instructions (as described in the program notes) relate directly to buttons or toggles on the patch. Otherwise, instructions are designed to tell the player exactly what to change on the patch. For example, “Set FB 1 to about 75% and keep improvising long tones with the

previous notes.” The work is based around the natural E-minor scale, though one chromatic note is included: F4.

The patch for “Recurrence” (fig. 4.6) is relatively easy to navigate. The green toggle button on the left will turn audio on and/or off. All of the input and volume sliders, except for the Master slider, are set automatically. To perform the patch, the performer will simply set the Master slider when ready and click on the “Rec_1” button to start recording to the first looper. Similarly, “Rec_2” will start recording to the second looper and so on. As can be seen, this is more or less the same process from “Loop Da Loop.” The difference here is that in “Loop Da Loop” the looping controls were automated while in “Recurrence” the player will need to engage with the patch. Perhaps the most important controls for the patch are the two feedback sliders marked “FB_1” and “FB_2.” Both sliders control the feedback amounts represented by percentage. 100% feedback will play each loop at full volume while a 50% feedback will play the loop at half volume for each loop (effectively creating a variable time delay).

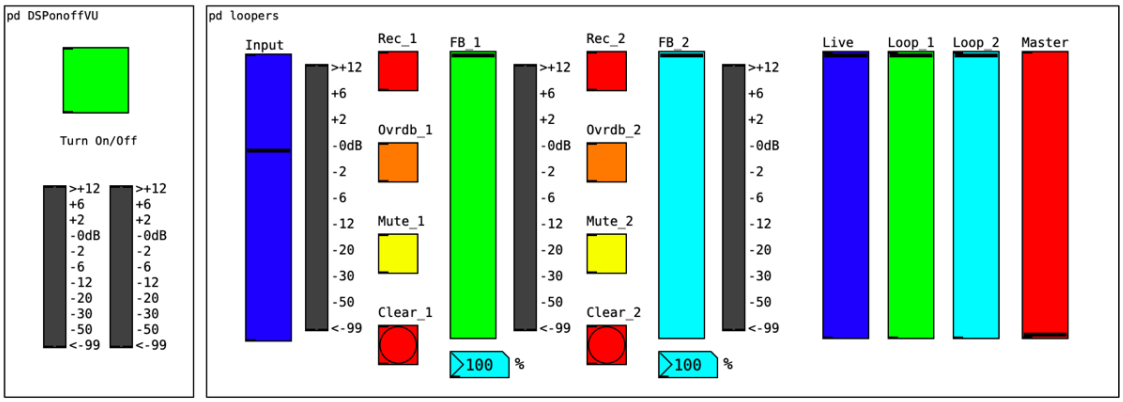


Figure 4.6. “Recurrence”.

4.8 “Enter. Play.”

“Enter. Play.” is an etude for clarinet and fixed media. In this case, the fixed media is performed by Pure Data in the form of an automated synthesizer. The work is

based on shifting sequences between a C and A whole tone scale (D and B for the B-flat clarinet). The lowest note is an A-sharp4 and the highest note is an E5. The etude is in 4/4 time and is at 110 BPM. Throughout the piece are several sixteenth note figures that interlock with the sequence played by the synthesizer. As such, the performer will need to learn how to play their part with accuracy and independence. Otherwise, the danger of playing out of sync with the synthesizer will increase with each passing repeat. Other than that, this is a relatively straightforward etude.

The patch, on the other hand, is more complex (fig. 4.7). Despite this complexity, little needs to be set up in order to play the piece. Audio is turned on with the green button in the upper left-hand side. On the right-hand side are mix and live effects controls that the user can set for balancing purposes. It should be noted, however, that this particular etude does not require the musician to be amplified even though I still recommend it. A secondary green button labeled “Start” is located on the left of the patch. Once toggled, this will initiate the sequencer and begin playing the patch. Tempo controls are included so the performer can play along to the patch at a slower (or faster) tempo for practice. Above the sequencer section are the synthesizer controls. Both the sequencer and synthesizer settings can be changed by toggling the “Mess Around” button in the sequencer controls. This way the performer can experiment with their own synthesized creations. The “Reset” button returns the synth/sequencer to their initial settings.

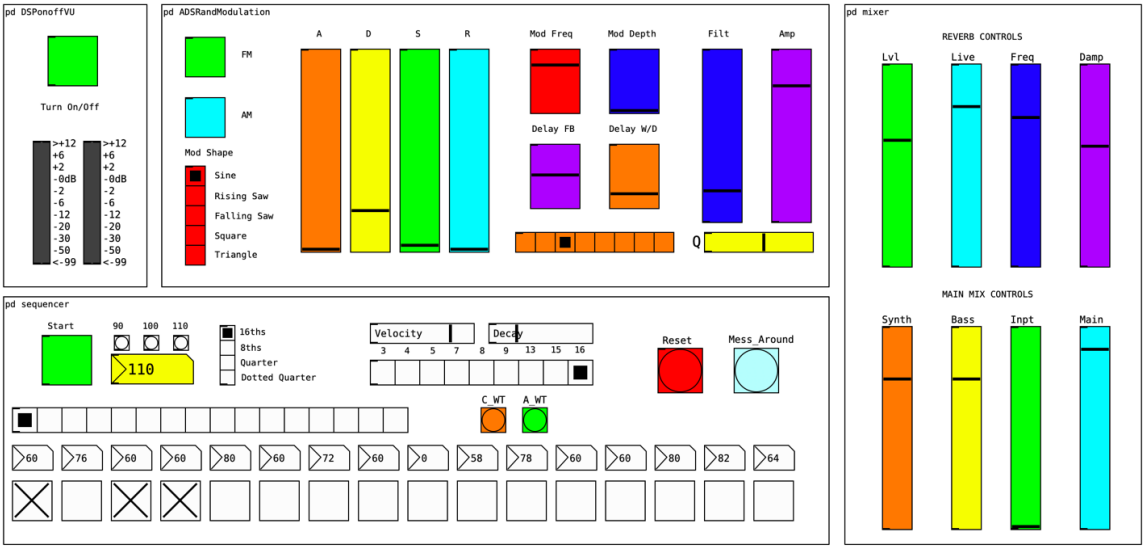


Figure 4.7. “Enter. Play.”.

4.9 “A Man From Mars”

“A Man From Mars” is another fixed media piece. Unlike the previous etude where the fixed media was performed using a programmed synthesizer, this piece uses a backing track much like “tape” pieces from the mid-twentieth century. Taking influence from hip hop and trip hop, this work is relatively straightforward since the performer really only needs to start the track and play along. The lowest note in the work is a F3 while the highest is a D5. The piece is marked at 80 BPM for the half note tempo. The fastest notes are eighth notes with several triplet figures and phrases throughout. The entire work utilizes the D minor pentatonic scale for the melodic material. At measure 37 is a “Solo” section with a pre-written solo. In the program notes, the player is encouraged, however, improvise their solo during this section.

The patch for this etude (fig. 4.8) is similarly simple and straightforward. On the left are several buttons and the green toggle button for turning audio on in Pd. Each blue button starts playing a different version of the backing track. The first button starts the

performance version of “A Man From Mars.” The second button starts a version that includes a click track. The third button starts a version with a click track at 140 BPM instead of 180. To the right are three sliders with accompanying level meters: one for input, one for the backing track, and one for main output. You can easily perform it without using any input if desired. However, I recommend in the program notes to utilize some live sound amplification for balance purposes.

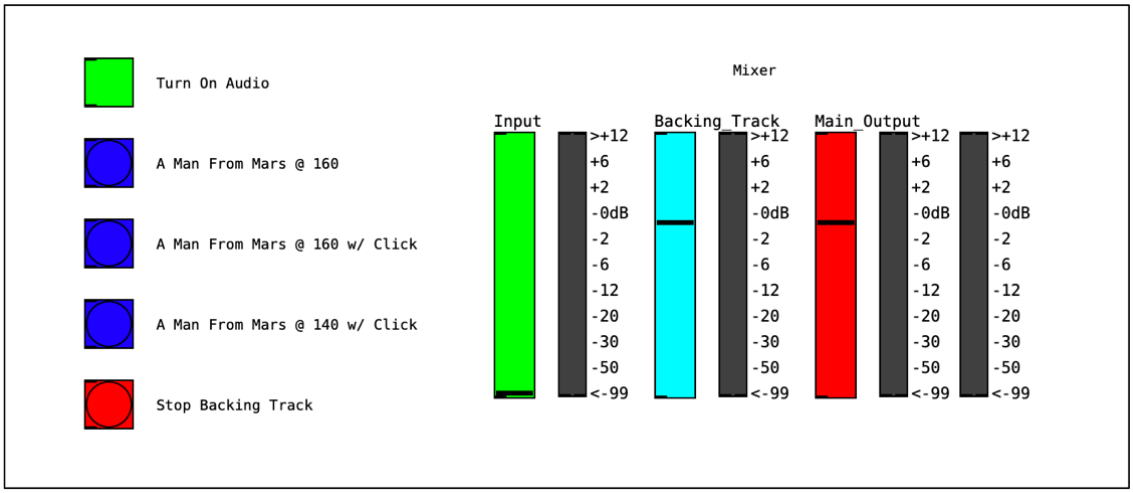


Figure 4.8. “A Man From Mars”.

4.10 “A Grain of Truth”

“A Grain of Truth” is another interactive etude; however, it requires the performer to interact with the patch during performance, meaning that not only does the patch interact with the performer, but the performer must participate with the workings of the patch. The lowest note in this etude is an E3 and the highest written note is a D-flat6. This particular etude leaves room for improvisation during several sections so the performer may choose to play notes that are higher than a D-flat6, but it is not required. While the work begins in 4/4 time with a tempo marking of quarter note equals 60 BPM, the time signature and tempo changes several times throughout. The performer can also

use significant amounts of rubato. The piece is based on several 5-note sets that were determined using musical dice (twelve-sided die that had the notes of the chromatic scale written on the sides). At several moments, such as on the third line of the score, the performer will have a chance to improvise with one of these 5 note sets as the patch manipulates and changes the live sound. Several of the repeats (such as at measure 10) are ad lib., as indicated in the score. The most important moments, however, come at measures 9, 14, 17, 19, 28, and 34.

At these sections are circled numerical markings that indicate when the performer is to press a corresponding button that changes the patch. These markings are to be pressed while the performer is holding a note (except for one exception at measure 19 when the performer can press the button *after* their last note of that section). Each note was carefully chosen to ensure that a clarinet player will have one hand available.[49] One might be tempted to ask, "Why not utilize some kind of foot controller to help facilitate performance?" Normally I would advocate using some kind of foot controller to facilitate triggering the patch (as I did for several of the works listed in Chapter 2), but since most people do not own one, I did not include it here. Additionally, programming for foot controllers would be difficult and would rely on a universal programming that simply does not exist. Instead, I decided to make the action of having to reach over to the computer and pressing a button while holding a note a part of the performance.[50] Each numeral in the score corresponds to the numbered keys on a computer keyboard.

[49] It is recommended, then, that the performer either use a neck strap or be seated to perform this etude.
[50] And part of the challenge.

To initiate the patch (fig. 4.9), the player must first turn audio on by toggling the green button in the upper left-hand corner. Then the player will adjust the slider for input (on the left) and the slider for master output (on the right). Once levels are set, the performer can simply begin playing and performing through the score. As mentioned above, pressing the numerical keys will change the parameters of the patch to correspond with the different sections of the work. I recommend spending some time on each patch setting to acclimatize to the sound and how the patch reacts to your playing. Some time spent working on your physical setup will also be required since the computer keyboard will need to be within arm's reach in order to operate the patch. In almost every case where the performer needs to press a numerical key, you will be playing a note that requires only the left hand. Therefore, keeping the computer to your right makes the most sense. You may also consider sitting for this etude or using a neck strap to steady the clarinet.

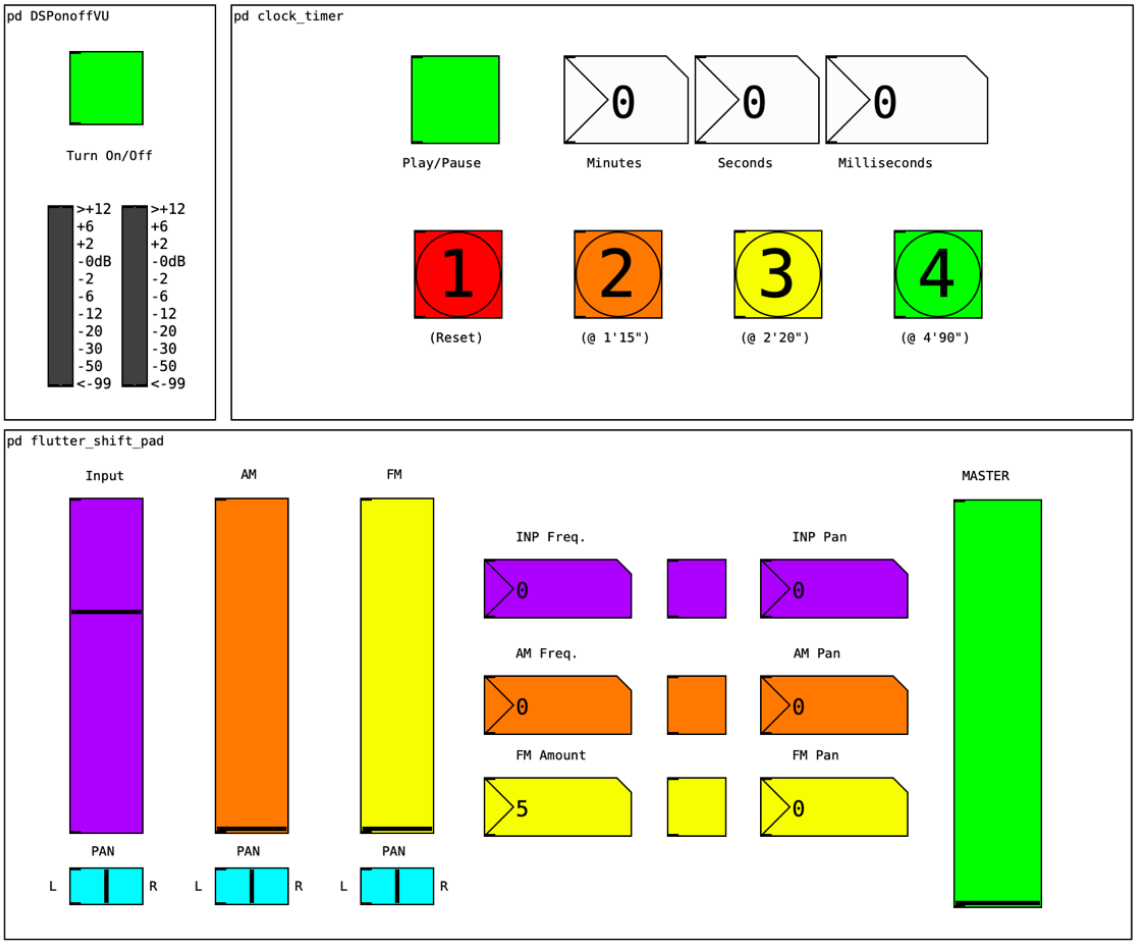


Figure 4.9. “A Grain of Truth”.

4.11 “Flutter & Shift”

The final etude of the set, “Flutter & Shift”, is also the most difficult. As described in the program notes, this is my homage to Morton Subotnick’s *Passages of the Beast* for clarinet and ghost electronics. Much like Subotnick’s work, this piece uses frequency and amplitude modulation to change the sound of the performer along with a low frequency oscillator manipulating the stereophonic panning of the output. The lowest note in the score is an E3 while the highest note is a F5. The fastest written rhythm is a 32nd note, with many sixteenth notes figure throughout, including sixteenth quintuplets. Tempo fluctuates dramatically throughout the piece and changes often with many

moments of rubato. At measure 26, the tempo is marked “very in time” with a dotted-eighth note at 140 BPM. No time signature is included in the score. However, several time markings help the performer align with the built-in timer in the patch. Accurate timing is necessary for the performer stay synchronized with the automated electronic manipulation. A number of glissandi, trills, and grace notes are included throughout, requiring some time to perform with confidence. Lastly, written instructions should be adhered to, such as “Start soft, gradually get faster & faster.”

The patch for “Flutter & Shift” (fig. 4.10) is surprisingly simple (at least for the user). In the upper left-hand corner is the (hopefully) by now familiar audio on/off button that I have used for each etude. Along the bottom are the controls for input, panning, modulation, and main output. The performer will need to adjust the Input and Master faders for performance. The other faders, however, are automated and will be manipulated by the patch itself (though there is a way to “play” with these settings which is mentioned in the program notes). On the top right is the timer section. To start the patch, simply toggle the “Play/Pause” button and the timer will begin alongside the automated manipulation of the Amplitude Modulation, Frequency Modulation, and Panning. The four colored buttons underneath the timer are designed to help the performer practice specific sections of the piece based on different times in the score.

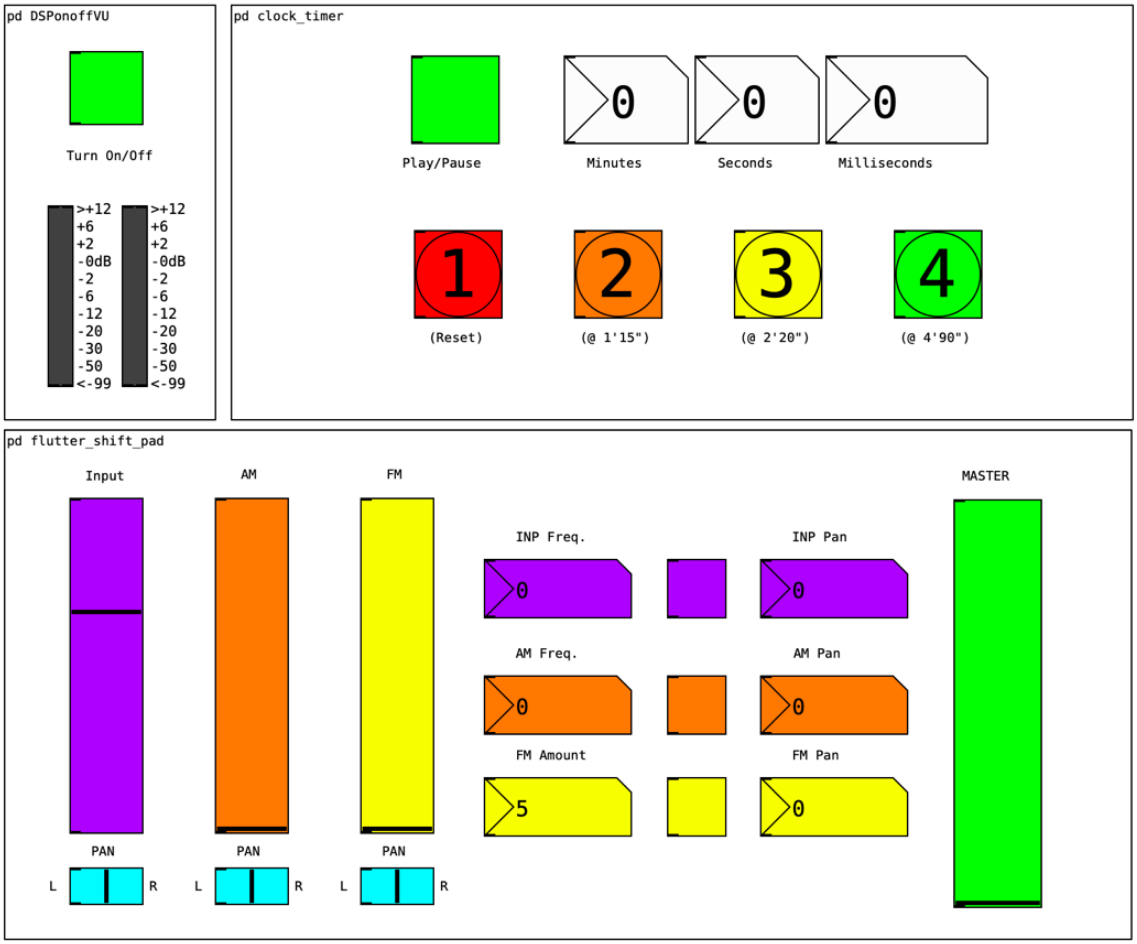


Figure 4.10. “Flutter & Shift”.

CHAPTER 5.0

A LIST OF RECOMMENDED EQUIPMENT TO PERFORM THE ELECTROACOUSTIC ETUDES

5.1 INTRODUCTION

As mentioned earlier in this document, one of the more important aspects of electroacoustic music is having the equipment (or access to equipment) to perform electronic music. The *Electroacoustic Etudes* have been devised to operate on a number of different systems so as to reduce some of the more prohibitive aspects of electroacoustic music, such as cost, space, or maintenance. Still, some investment will be required to perform these etudes. Most notably a computer is required (to be described later) for digital sound processing. After the computer, any number of devices can be utilized for both practice and performance. At its most basic, a performance system will include some way to get sound into the computer and some way to get sound out (Input/Output).

Considering these basics, we can start to look at different kinds of electronic systems in order to perform the etudes. Each system is modular and can be adjusted, and each system has its own benefits and drawbacks. For ease, I have arranged a short list of electronic systems based on cost, ease of use, sound quality, and a subjective description of the advantages and disadvantages for each system. For prices, I have consulted popular websites such as sweetwater.com, bestbuy.com, and apple.com to approximate cost for each system (at the time of writing this document).

5.2 Level 1: Default Computer Input and Headphones

According to Johannes Kreidler, “First you need a computer with at least 128 MB main memory, a 500 MHz processor and ca. 500 MB hard disk space (these are the absolute minimum requirements!). Pd works with the following operating systems: Linux,

OS X, and Windows."[51] I own and use a MacBook Pro from early 2019 that, according to apple.com[52], starts at $1299.00 for the basic model. However, a cheaper Windows compatible model such as HP's Pavilion x360 currently going for $699.00 on bestbuy.com[53] should be more than capable enough to handle Pd's minimum requirements. A computer with additional RAM, processing speed, and storage space will, however, process live and modulated sound more easily, reducing the possibility of audio failure, crashes, or dropouts. So, if there is one piece of equipment you should invest in or make sure you have access to, it is a decent, modern computer. In both of these cases, the built-in microphone can be used as an input device.

Meanwhile, any pair of headphones would work as a sound output device. Most modern computers will have a 1/8th inch jack for headphones. I recommend a pair of over-the-ear, wired headphones to be used, such as Sony's MDR-7502 available for $49.99 at sweetwater.com.[54] You can use wireless headphones, but latency and connection issues may present problems avoidable by using wired headphones. A cheaper pair of headphones are also perfectly usable, but much like a computer, an investment in a nice pair of headphones can help give you a better experience, and you can use your headphones for many other applications. You may ask yourself, "Why not just use the built-in speakers on my laptop?" The answer is *feedback*. Most built-in microphones are close enough to the computer's speakers that any live sound processing will most likely lead to feedback, which is usually undesirable. Therefore, you

[51] Johannes Kreidler, *Loadbang: Programming Electronic Music in Pd* (Freiburg: Wolke 2009), Accessed March 2, 2020, http://www.pd-tutorial.com/english/index.html.
[52] Apple, www.apple.com.
[53] Best Buy, www.bestbuy.com.
[54] Sweetwater, www.sweetwater.com.

will want a separate output device, such as a pair of headphones, to monitor your performance.

The biggest benefit of the above setup is that it is by far the cheapest option and an option to which most households in North America would most likely have access to. Similarly, most public education institutions would have at least one computer for students to access. Thus, most students would be able to download Pd, download the patches, set up Pd's input/output settings and start playing. As an introduction to learning and performing electroacoustic music this is, *technically*, all you need. Input and output at its simplest.

This system, however, is not capable of actually *performing* the etudes since the only output device is the headphones. For *practicing*, however, this system can be ideal since it is both cheap and portable. For actual performance the computer's output would need to be plugged in to a PA system. This is very doable since most venues and institutions have a way to get sound from a computer and into the house PA system. The biggest drawback of this system, however, is arguably the most important: sound quality. The microphone inputs included on most computers are not meant for musical performance and are instead utilized for simple communication applications such as Skype or Google Meet. Even when practicing this can be a drawback since the quality of the input would be low. This leads us to our next level.

5.3 Level 2: Pickup with USB DAC Adapter and Computer Speakers

This next level introduces the use of a Pickup with the instrument. I use the PiezoBarrel "Wood" pickup by an Australian company called PiezoBarrel. You can currently order a PiezoBarrel Pickup (with a pre-drilled 65mm clarinet barrel) from their

eBay store for $119.00 AU.[55] According to piezobarrel.com these pickups are, “Designed to provide a warm tone, the 'Wood' offers high output, eliminates feedback and prevents spill without requiring external power or a preamplifier. It is great for live performance and designed to take advantage of effect pedals.”[56] Using this pickup (or one like it) you could easily use a 1/8th inch to 1/8th inch cable to plug in to your computer’s input. Or you could elect to use a simple USB adapter such as Sound Blaster’s PLAY! 3 currently advertised for $24.99 at Sound Blaster’s website.[57] An adapter like the Sound Blaster PLAY! 3 is a Digital Audio Converter (DAC) that acts as an external sound card to your computer. With the PLAY! 3 plugged in you would set the Pd’s input settings accordingly and then set the output to either your computer’s default output or the PLAY! 3’s output. Then, if you wanted to monitor without headphones, connect a set of computer speakers like Logitech’s z323 speaker system currently listed on bestbuy.com for $49.99.[58] (note: computer speakers range dramatically in price. I simply picked a system I was familiar with and was under $50.)

The most obvious benefit to this level of equipment is that other people can hear the performance and the risk of feedback is greatly reduced. The pickup provides a clear, warm tone for the clarinet to be processed with and won’t feedback as long as the speakers aren’t directly next to the pickup. Utilizing a simple DAC adapter like the one mentioned above can help alleviate CPU usage which may help some patches run more smoothly. However, there is still an issue of quality in the sound. While the computer speakers themselves are usable they may not produce enough sound to fill a concert hall. Furthermore, small speaker setups like this tend to sound “tinny” and “thin”. In that

[55] Ebay, Accessed April 10, 2020, www.ebay.com.
[56] PiezoBarrel, Accessed April 10, 2020, www.piezobarrel.com.
[57] Creative, Accessed April 10, 2020, us.creative.com.
[58] Best Buy, Accessed April 10, 2020, www.betsbuy.com.

case either plugging in to a venue's PA system (as mentioned before) or using a small amp such as Marshall's MG10G (currently listed for $89.99 on sweetwater.com[59]) would help (I like Marshall's MG line because it has a 1/8th inch input. The MG's also come in various sizes for those of us that want more "Oompf"). For a more improved sound, however, another piece of equipment would be required.

5.4 Level 3: Pickup with an Audio Interface and a Powered Amplifier

To achieve a better sound and provide even more support to your computer's CPU the use of an audio interface is advisable. There are numerous Audio Interfaces available and the next few levels will explore a few options. The 3rd Generation Scarlett 2i2 by Focusrite is a reliable and affordable USB Audio Interface available for $159.00.[60] Thanks to the built-in preamplifier and the combination XLR/Instrument connector for various inputs the Focusrite Scarlett will provide improved input and output audio quality. The Scarlett also has separate volume controls for input and output and includes a "direct monitor" feature that allows you to monitor your input.[61] In a live situation, having control over the volume of both input and output can be a crucial for setting the balance between live and processed sounds. For output from the audio interface, the performer can use a powered amplifier or speaker such as the Marshall amp mentioned above or a powered speaker system like the Mackie Thump12a currently available for $399.99.[62]

As you can see, things are starting to get more expensive. Which is by far and away the biggest downside to this and the next few levels we will discuss. It should not be forgotten, I might add, that at this point we are still assuming you have both a

[59] Sweetwater, Accessed April 10, 2020, www.sweetwater.com.
[60] Ibid..
[61] Very useful for when you are practicing or are in a large space and need to hear yourself through a monitor on stage.
[62] Sweetwater, Accessed April 10, 2020, www.sweetwater.com.

computer and a clarinet! Both of which are expensive enough as is. But again - if you don't want to spend money on an amplifier system that is probably fine since most venues have at least one PA that you can plug your interface in to. For practice at home you could then utilize a pair of headphones or a cheaper set of powered speakers or amplifier. I would, however, highly recommend that you invest in an Audio Interface of some kind since it gives you significantly more power, flexibility, and sound quality than the previous options. With that let's explore some higher quality options.

5.5 Level 4: Higher Quality Interface with Stereo PA

For high quality sound and even more flexibility, you may want to invest in a higher performance audio interface. Again, there are several options available to you and prices vary depending on options. The Apogee Duet audio interface is a high-quality interface specifically designed for Apple products that features several connectivity features (including the ability to work with iOS on phones and tablets). With 4 inputs and 4 outputs built-in you have several ways of interacting with the computer and sending sound. The benefit to having more than two outputs is that you can set up a "monitor" of your sound which can really help to hear what is happening while you are on stage. The Apogee Duet is currently listed on sweetwater.com for $649.00.[63] The Apollo Twin is another attractive interface with even more input and output options than The Duet. Plus, Universal Audio's Apollo Twin was designed for use with Windows so if you are a PC user this is a very good option. The Twin is currently listed for $899.00 on sweetwater.com.[64] Similar to the two options above is Arturia's AudioFuse currently

[63] Sweetwater, Accessed April 10, 2020, www.sweetwater.com.
[64] Ibid.

listed for $599.00.[65] The AudioFuse has several hardware features that are useful if you want to start DJing or doing other types of electronic music.

If you're looking to expand your audio capabilities and want as many inputs as you can get, you might consider an audio interface such as Focusrite's Clarett 8Pre USB. Listed for $869.00 at sweetwater.com,[66] the Clarett 8Pre offers eight XLR/Instrument inputs and 8 built-in outputs plus the ability to expand via optical or S/PDIF inputs. At this point, we are venturing into the world of "professional" audio interfaces, meaning that they may be the kind of interfaces that you would see in a recording studio. Prices increase dramatically for these devices such as the Apogee Symphony range that starts at over $3,000.[67] As a performer, you really do not *need* an interface in this range, especially for the *Electroacoustic Etudes* since they only require a single input and, at most, two outputs! So, anything more is unnecessary.

If you are going to use a high-quality interface, then I recommend an output method that matches the quality of the interface. In my home studio, I use a pair of KRK Rokit 8-inch speakers which currently retail for $299.00 each.[68] The Rockit line is designed as a line of moderately priced studio monitors and I have enjoyed my pair immensely. Usually, though, you would not use studio monitors for live performance since they are often designed for near-field listening. Instead, a pair of the Mackie Thumps (mentioned above) might be better. If you want a professional level live sound setup, I might recommend the QSC K8.2 2000W 8-inch powered speakers that retail for $649.99 each. These speakers, combined with a high-quality interface, produce an amazing sound—I have performed with a similar setup in the past. While the K8.2 line is

[65] Sweetwater, Accessed April 10, 2020, www.sweetwater.com.
[66] Ibid.
[67] Ibid.
[68] Ibid.

available in varying sizes, the 8-inch speakers create a surprising amount of sound that easily fill a recital hall. It should be noted that this is all *technically* more than you need to perform these etudes, and you really do not need to spend upward of two thousand dollars.[69]

Level 5: Higher Quality Input Options

If you are going to use a high-quality setup option like the options outlined above, you may want a higher quality input. First, the PiezoBarrel system is a very high-quality system, but like any "pickup," the sound can be "muffled" or overly "flat." I usually counteract this by using equalization (EQ) software to "sweeten" the sound but an excellent hardware solution is the LR Baggs Venue DI Acoustic Preamp EQ selling for $299.00.[70] The Venue is marketed as a "full solution DI" (DI stands for "direct input") that allows the user to adjust equalization settings, boost signal, mute signal, and more. It even includes a built-in tuner! I really like this device since it has so many options, all controllable from a series of knobs. Every venue is different and having the ability to control your own sound can vastly improve the performance experience.

But what if you would prefer to use a microphone instead of a pickup? For live performance, the Shure SM58 (currently available for $99.00[71]) is an excellent, durable option. The SM58[72] has long been a standard in both live and recorded sound situations. It is durable, consistent, and sounds good. Its dynamic cardioid pattern is great for picking up sound directly in front of the microphone and not picking up additional off-axis

[69] Note that you can just use the venue's speakers and use headphones at home to practice.
[70] Sweetwater, Accessed April 10, 2020, www.sweetwater.com.
[71] Ibid.
[72] The SM58 is technically a vocal mic. Shure also makes the SM57 which is an instrument mic designed for instruments like brass. Brass instruments work well with the SM57 because of the direct sound from their bells. The clarinet, however, has indirect sound so a vocal mic like the SM58 is still preferable.

sound. This can be critical in a live situation to avoid feedback or processing unwanted ambient sounds. This, however, presents a problem for the clarinet. Since the clarinet's sound emanates from multiple holes around the instrument, mic placement is crucial. I have found that placing the mic somewhere between the two hands and pointing at or just below the middle joint does the best. Another option is to place the mic "above" you (such as above the stand) and pointing towards the player. You will need to increase the gain, however, which could potentially lead to feedback issues. Experimentation is recommended to find what is best for your needs.

For recording purposes, a diaphragm condenser microphone would be preferable. Bass clarinetist Michael Lowenstern provides an excellent argument for condenser microphones and provides several options in his Video Essay "6 Microphones Under $1,500, 3 Positions, 1 Bass Clarinet. The Ultimate Test."[73] Along with the Shure SM58, he previews the Audio-Technica AT4050 ($699.00), Neumann KM184 ($799.00), Coles 4040, and SE Electronics 2200a ($299.00).[74, 75] Lowenstern's video is dedicated to using these microphones with the bass clarinet, however, much of the same information applies to the clarinet as well. I have personally used both the Neumann and Audio-Technica mics in recording situations and can attest to their abilities. Regardless, if you plan on recording your own music or just want a really good microphone for your home practice any of these options would be good.

[73] Michael Lowenstern, "6 Microphones Under $1,500, 3 Positions, 1 Bass Clarinet. The Ultimate Test." https://www.youtube.com/watch?v=zuxubJM5OAE.
[74] Sweetwater, Accessed April 10, 2020, www.sweetwater.com.
[75] As of October 2019 Michael Lowenstern has also reviewed the DPA d:vote 4099 on his YouTube channel. I recommend watching that video as well.

5.7 Practicing and Performing

Before I conclude this segment, I want to give a few personal notes on performing and practicing with electroacoustic systems like the ones mentioned above. In July and August 1983, a two-part series titled “The Studio as a Compositional Tool” by Brian Eno and edited by Howard Mandel was published in *Down Beat*. The article was Eno’s depiction of how he uses the recording studio to act as a tool for creating music. Eno argues that “the studio as music tool” allows the composer to experiment and “layer” elements on recorded tape. The result is that the modern recording studio becomes a fundamentally different and important tool and/or instrument to modern composition.[76] I have been significantly inspired by this approach, and I believe you can apply the same thinking to your own home studio or electroacoustic setup. To understand what I mean, recall when you first started to learn your main instrument. What sort of things did you *do* to *learn* the instrument? You experimented, tried new approaches, listened to people more knowledgeable than you, and listened to the results. You should do the same with your electroacoustic setup both at home and on stage! *Learn* the “instrument” and apply it to your sound. See what works best and try to remember (or write down) what you did for future performances.

And, as with any instrument, there may be moments where things simply do not work. In October 2019, I gave a guest recital at Glendale Community College. I had just begun playing Michael Lowenstern’s piece “Drift” when, all of a sudden, my audio interface turned off! The backing track that was playing obviously suddenly stopped and I was left playing alone. Despite the fact that I was in a live situation, I quickly determined that the surge protector to which I had my equipment plugged in (by the way,

[76] Brian Eno, ed. Christoph Cox and Daniel Warner. “The Studio as a Compositional Tool”, *Audio Culture: Readings in Modern Music.* (New York: Bloomsbury, 2017), 383 - 390.

you may want to purchase a nice surge protector) had been tripped due to a plugged-in space heater! The recital hall was unusually cold, and my host had graciously set up the space heater for me. Had we known that it would overload the surge protector we obviously would not have used it. After unplugging the space heater, I calmly turned everything back on, made some light and humorous quips with the audience, and got everything back up and running. In other words: Critical failure does not automatically mean the end of a performance! Sometimes a pad comes loose on your clarinet. Some quick thinking can get it back to working condition. It is the same with your electronic *instrument*.

5.8 Conclusion

Playing electronic music, of any kind, requires some investment. The above options, however, demonstrate that a lot can be done using budget systems. Nonetheless, the performer (whether you or one of your students) should be prepared to either purchase or gain access to the necessary equipment. Higher quality systems will provide higher quality sonic results and offer additional capabilities, but they will cost more. Furthermore, it should be noted that the above options are by no means the only options. Experimentation, access, and availability will all play crucial roles in developing an electroacoustic system for performance. Many other input and output devices are available that this document did not cover.[77] With any luck, the above options will, at some point, become obsolete as better systems, computers, interfaces, and inputs become commercially available.

[77] Such as the viga “intramic” system available at http://www.vigamusictools.fr. I have not personally tried this system yet, but you can read a review about viga at www.jasonalder.com.

CHAPTER 6.0

ELECTROACOUSTIC ETUDES FOR CLARINET AND PURE DATA

6.1 INTRODUCTION

This section presents the etudes as they will be delivered to students and pedagogues. Each etude, as previously mentioned, includes a score and a set of program notes. The program notes will be presented as the first page followed by the score for each etude. The Pd patches, meanwhile, will be provided as a separate download from the scores/instructions. The program notes are critical in order to give the performer an explanation of how to operate the patches and approach some of the elements in the written score. The program notes also feature some additional information. Each program note features four sections: (1) A “What is…?” section that describes the type of effect or processing featured in the etude; (2) A “Getting Set Up” section that explains how to set up the patch and elements to look for in the score; (3) A “What Else Can You Do?”[78] section that suggests ways to use the patch outside the written score and encourage the performer to try some different creative ideas; and (4) A “Further Listening” section with links and suggestions to listen to electroacoustic music that either inspired the etude or are similar to the etude.

[78] It is necessary to point out that I took inspiration from a favorite cookbook of mine titled *Well Fed* by Melissa Joulwan. In the cookbook, Joulwan includes a section called “YOU KNOW HOW YOU COULD DO THAT?” inspired by what her father would say to her after teaching her to cook a dish.

6.2 “Moving Through Space/Time”

Moving Through Space/Time

an etude for clarinet and filter delay

What is a Filter Delay?

Every sound you make has a “spectrum” of sounds: a sound on top of a sound on top of a sound. An Audio Filter takes a tiny portion of your sound and either increases the volume or decreases the volume depending on how the filter is set. So, just like a coffee filter filters out things you don’t want (coffee grounds) and leaves things you do (delicious coffee) our Filter does the same. Our filter here, though, filters out certain parts of the spectrum while boosting other parts of the spectrum. Meanwhile a Delay Line takes a sound and *delays* its output. In other words: your computer saves the sound you perform and plays it later. With different settings you can change how many times the delayed sound is played (feedback) and how quickly the delayed sound occurs (usually in milliseconds). The higher the feedback the louder the repeated delay is so be careful! By combining these two elements with 3 Spectral Delay lines we can create an immense *spacey* sound just from one instrument!

Getting Set Up

The etude patch should open with a number of settings *initialized* (Init). Before you begin, make sure that your audio input/output settings are set up correctly. If your input settings aren’t correct things can get too loud too quickly. Once your settings are good click the green button. Then play the etude and enjoy your new spectral sound!

What Else Can You Do?

As you can see in the patch there are several sliders that can be adjusted. Try experimenting with different sliders and see if you can create your own version of the sound effect. Furthermore, each filter can also be adjusted. In fact, you can actually DRAW in the spectral filters to change the settings with your mouse! Try drawing around in each filter and see what happens.

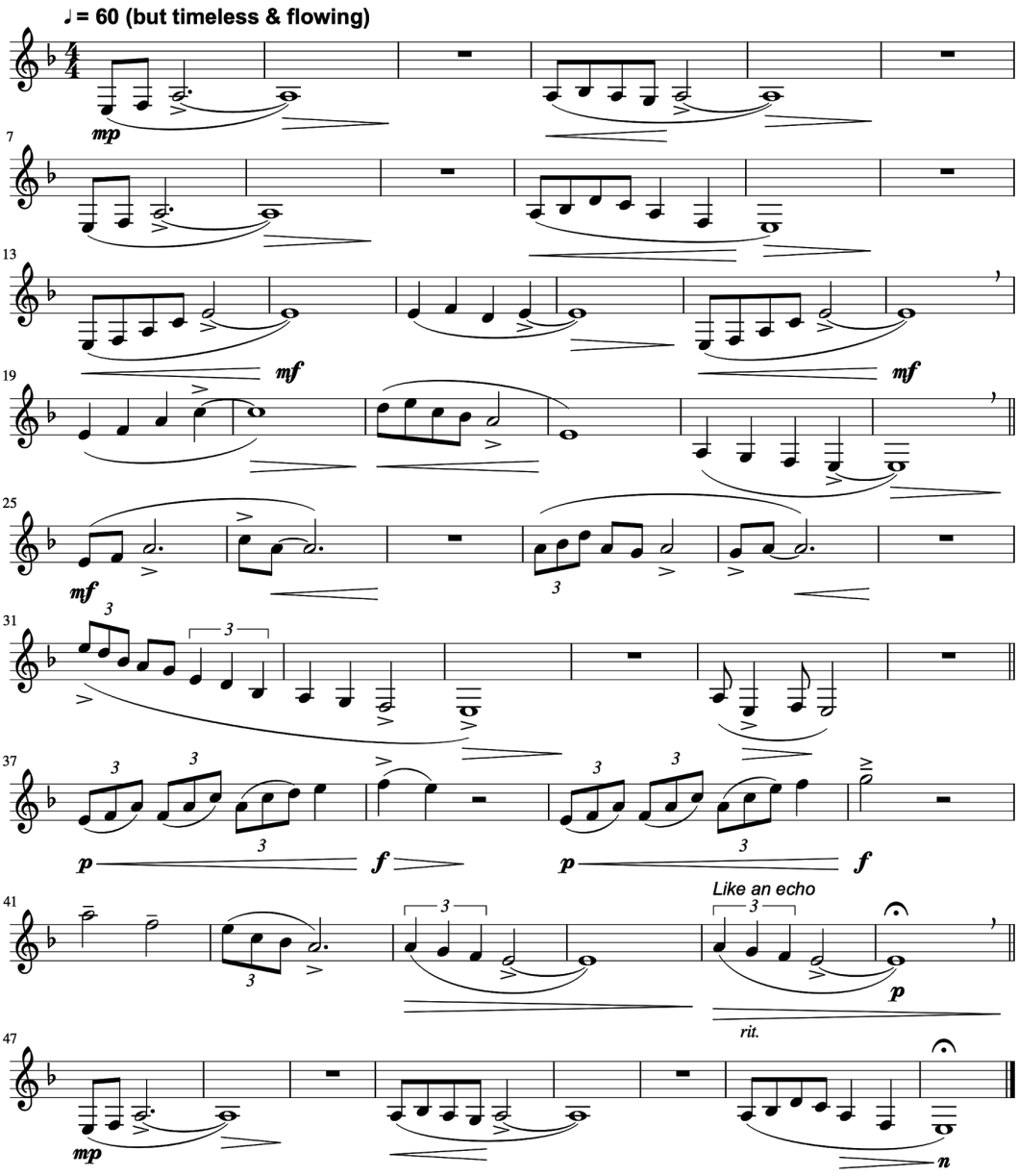
Further Listening

Cort Lippe is a composer who was a researcher and artist at the Institute for Research and Coordination in Acoustics/Music (IRCAM). Cort was a pioneer in spectral music and using computers to create spectral effects. His piece *Music for Bass Clarinet & Tape* features a lot of spectral effects on the tape part. Check out Cort’s website for recordings, scores, and so much more: https://www.cortlippe.com.

Moving Through Space/Time

an etude for clarinet and Pure Data

Josh Bennett



6.3 “System Delay”

System Delay

an electroacoustic etude for clarinet and simple delay

What is a Delay?

As the name suggests a delay takes a sound and recreates it later. Thus the sound is *delayed*. Each delayed sound is referred to as a “tap”. The speed of the taps are usually measured in milliseconds. The smaller the milliseconds the less time it takes between taps. The number of taps you hear depends on the amount of feedback. Feedback is when a sound is processed and then sent back, or fed back, to the sound processing device. The result is a sonic effect where the sound that was just performed comes back a short time later but just a little softer. Depending on how much feedback you have on your effect it either decays rapidly or over a longer period of time.

Getting Set Up

Begin by turning audio on with the green button. Then set the input and output levels and you are done! The two delays should be automatically set to 50% feedback and 250 milliseconds. This should result in a tempo of 120 BPM with eighth note taps that dissipate within four beats.

What Else Can You Do?

You will notice that there are two delays. If you are using stereo speakers or headphones try changing the speed of one delay while leaving the other as is. You could also adjust the feedback of either delay. Experiment with different settings and see how the effect changes. Try improvising with your new settings or play another piece of music with this effect on!

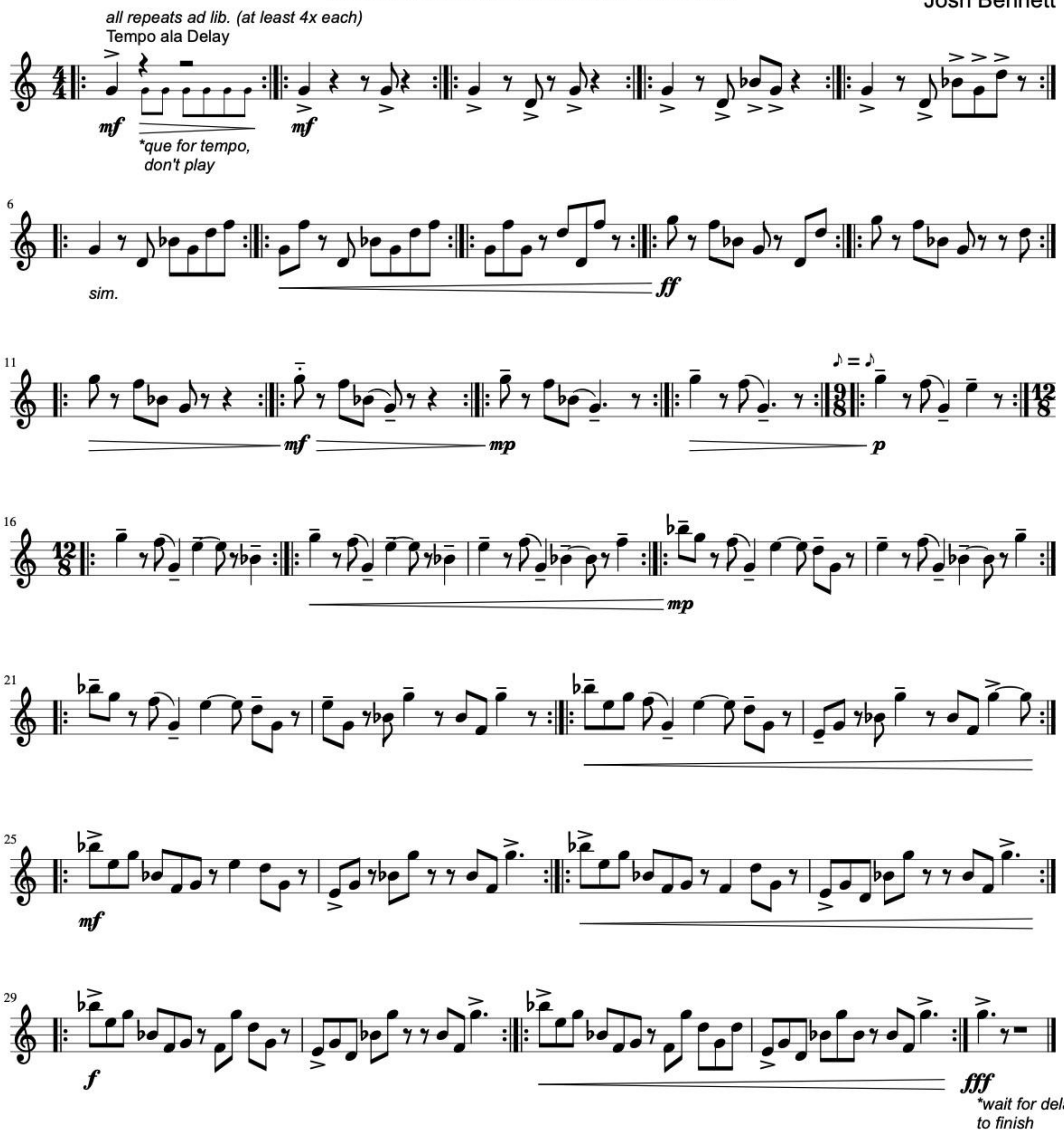
Further Listening

There are so many pieces and styles of music that utilize delays! A favorite of mine is “Robot March” by Cornelius Boots from the album *Robot Music*. You can find this work and several others at bassclarinet.bandcamp.com. Miles Davis was also fond of using an Echoplex delay pedal which he famously used on the album *Bitches Brew*.

System Delay

an etude for clarinet and Pure Data

Josh Bennett



6.4 “Berg(sonian) Klang”

Berg(sonian) Klang

an etude for clarinet and klangfarbe machine

What is a Klangfarbe Machine?

Klangfarbe is german for “The Timbre”. A Klangfarbe Machine, therefore, takes your sound and *adds* sounds that randomly generate different timbres. The result is an ever-changing sonic color based on whatever note you are playing. You will notice that the device also responds to your dynamic level. In this way you and the device are playing a duet. The music for *Berg(sonian) Klang* is based on a piece by Alban Berg called *4 Stücke* which utilizes a lot of silence and contrast. Since the Klangfarbe responds to dynamics, try *playing with the silence*. Take your time with the breath marks and give a lot of space with each rest. Really try to hold out the fermattas and be dramatic with both crescendos and decrescendos.

Getting Set Up

Click on the green “Turn on Audio” button and make any adjustments to the input settings. After that, you are pretty much done. Just play the piece and enjoy. The klangfarbe will take care of the rest.

What Else Can You Do?

Improvise! Improvise! Improvise! This is a really fun device to experiment with. Adjust all the different settings and see what kind of sounds you can make. You could also write your own piece to be used with the Klangfarbe. I used a piece by Berg to inspire me but what would a piece inspired by Kendrick Lamar or another popular artist sound like? Give it a try!

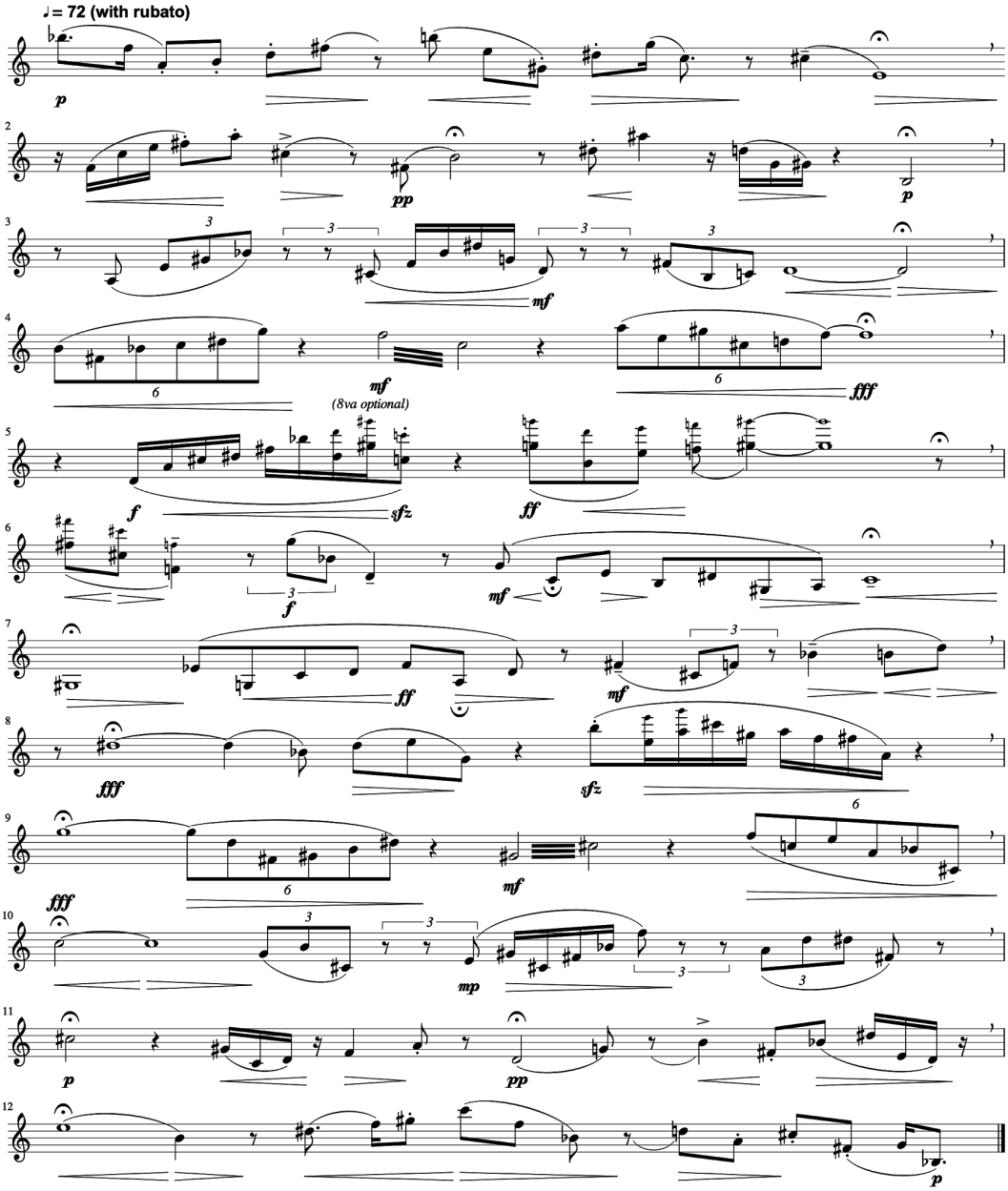
Further Listening

Karlheinz Stockhausen’s work *Mikrophonie* was an early example of interactive electronics and Stockhausen regularly used similar techniques to create his music. Here’s a performance of the first movement of *Mikrophonie* performed by Crossing 32nd Street:
https://www.youtube.com/watch?v=iMgqn7N3XrA

Berg(sonian) Klang

an etude for clarinet and Pure Data

Josh Bennett



6.5 “Distorted Reality”

Distorted Reality

an electroacoustic etude for clarinet and distortion

What is Distortion?

Distortion is when a sound signal is purposefully boosted and then clipped. In other words: the amplitude is increased and then *cut off*. This creates a harsh, buzzing sound that radically changes the timbre of the sound. Rock and Roll musicians have long used distortion to give their guitars a new and exciting sound quality. This particular etude is based off of the solo from “Eruption” by Van Halen. Eddie Van Halen (the guitarist) displays his technical skills on guitar while taking full advantage of the milieu of sounds that a distorted guitar can provide. Similarly, you will want to experiment with your sound and *drawing out* the sound of the distortion. Experiment with the pitch bends and try playing both as fast as possible and as accurately as possible to produce a wild, yet controlled, effect. Also, just like “Eruption”, see if you can spot the etude quote in this piece!

Getting Set Up

This patch is especially prone to feedback due to the boosted input signal. So double check that the input/output settings are correct in Pd before you play anything. Start by turning audio on with the green button. Turn up the Output slider and play a few notes. Do you like the sound? Try experimenting with the various sliders until you get a sound that makes you think “THIS ROCKS”. When you have a sound you like, start playing the etude!

What Else Can You Do?

Each time you play the etude try some new settings with the sliders. Maybe on your second playthrough try turning the Reverb up as much as you possibly can. Experiment with different output options. Does it sound better on a pair of computer speakers or on an amplifier? Try playing your favorite etude or solo work with distortion. I really like playing William Osborne’s *Rhapsody* with this patch. I would, also, love to see what you would compose for this patch!

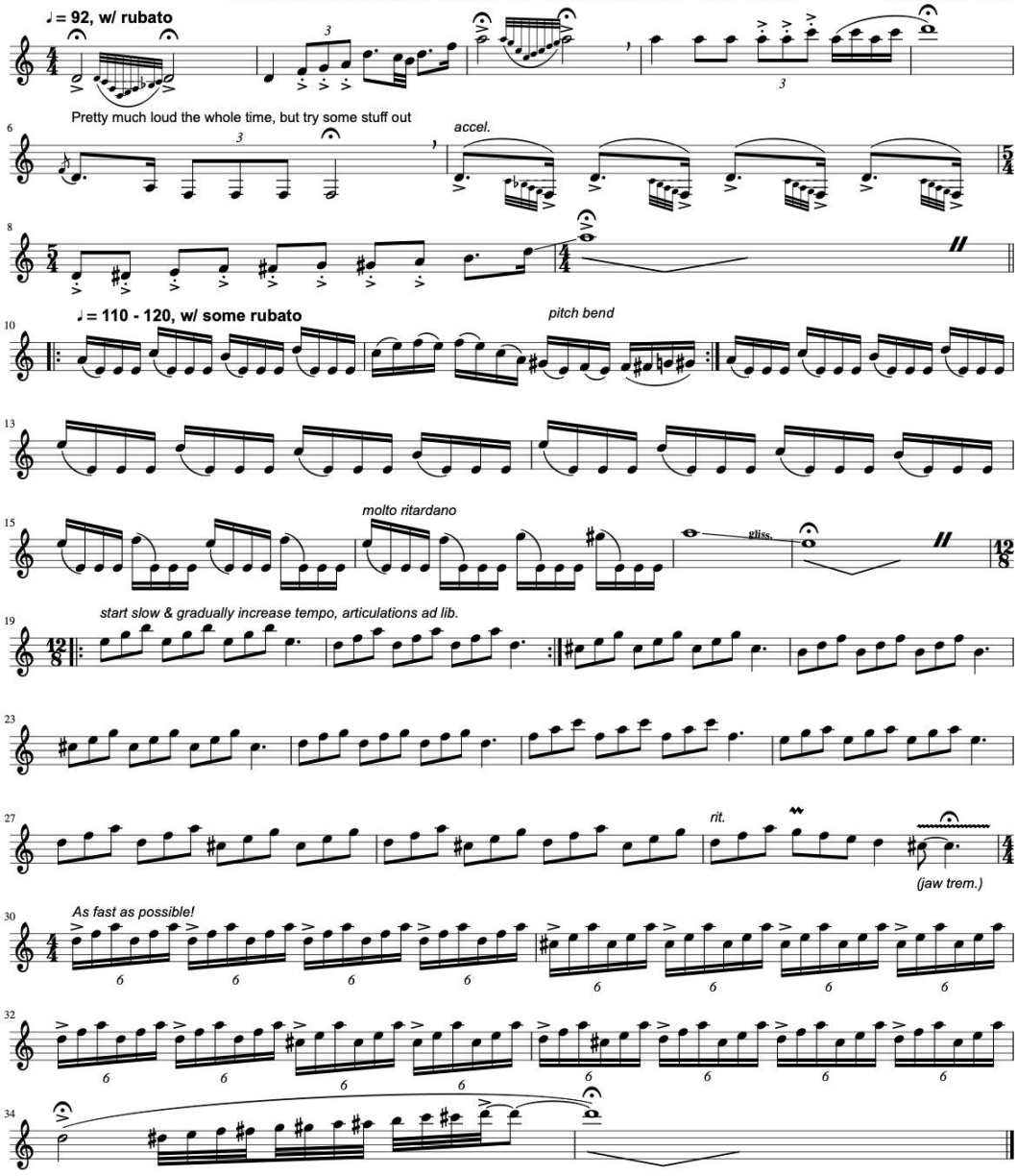
Further Listening

As mentioned above try listening to “Eruption” by Van Halen (you can find a recording on any number of streaming sites). Some other great rock musicians that utilize distortion regularly include Jimi Hendrix, Metallica, TOOL, and many, many more. Julia Crowe is one of my favorite guitar players and she often makes distortion sound beautiful rather than harsh. Here is her piece “Moth” from the album *Empire of Light*: https://www.youtube.com/watch?v=mrfXJ4Gp8rQ

Distorted Reality

an electroacoustic etude for clarinet and Pure Data

Josh Bennett



6.6 “Loop Da Loop”

Loop Da Loop

an electroacoustic etude for clarinet and looper

What is a Looper?

A looper is any device that records live audio and plays it back repeatedly. The term originally comes from the use of magnetic tape where musicians would feed a line of tape through a recorder then through a playback device and then back through the recorder. Today there are many devices and applications that replicate this process. The idea is that you record a piece of audio and then *loop* it where you can overdub on top of that loop to create several musical layers. The result is that you create an ensemble sound from just your own playing.

Getting Set Up

Whenever you work with a looping device it is very important to make sure that your audio input is isolated from your output. So if you’re using a microphone either make sure it is far away from the speakers or use headphones. Click the green button to turn on audio and set your input slider. When you are ready, click the green “Start” button to begin. You will notice there are four “beat” buttons that show you the beat. You can also turn on the “Click” if you want to practice with a metronome click. Use the mixer sliders on the right if you need to adjust the volume balance. Make sure to play in time since the patch is automated!

What Else Can You Do?

Once you’ve played through a few times see if you can make your own loop. You can also control the looper on your own rather than using the automation by using the “Rec” (record), “OverDb” (overdub), “Mute”, and “Clear” buttons.

Further Listening

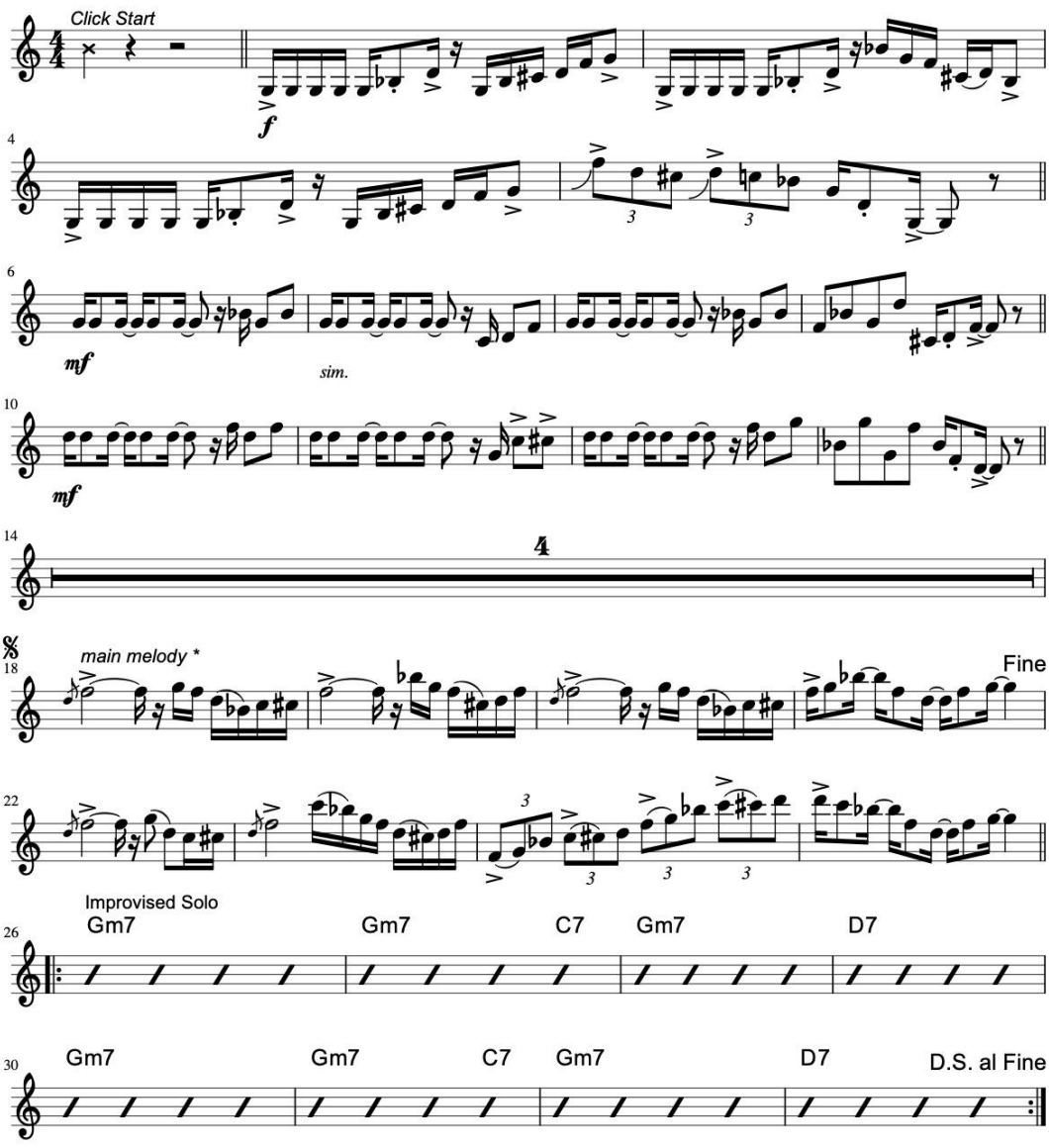
Zoë Keating makes some really great loop pieces for cello. Here she is playing her piece “Escape Artist” live in a studio: https://www.youtube.com/watch?v=yYrcXX4nWOA. Michael Lowenstern also makes looping pieces for bass clarinet and electronics. Here is an example of his piece “Drift” performed at the Switchboard Music Festival: https://www.youtube.com/watch?v=bt6-8AXGG3M.

Loop Da Loop

an etude for clarinet and Pure Data

Josh Bennett

♩ = 84, With Funk!



* On Fine: Decrescendo and slow down as other loops fade out

6.7 “Recurrence”

Recurrence

an electroacoustic etude for clarinet and loopers

What are loopers?

A looper is any device that records live audio and plays it back repeatedly. The term originally comes from the use of magnetic tape where musicians would feed a line of tape through a recorder then through a playback device and then back through the recorder. In *Recurrence* there are more than one looping devices operating at the same time. For this etude you will be taking advantage of the fact that when you play these tape loops “out of time” they can result in a psychoacoustic phenomenon called “phasing”. You will also utilize the looper’s “Feedback” slider. Feedback is the amount of recorded audio that you send back through the looping device. We will use feedback in order to fade live audio in and out of the soundscape as we perform.

Getting Set Up

Click the green button to toggle audio on. Before turning up the “Master” volume set the “Input” volume to a desired level. Remember to be careful when setting levels and if you are using a mic make sure to place the mic away from any output devices to avoid unwanted feedback. Once levels are set you can then turn up the “Master” slider to the desired level. On the score: boxed-in text corresponds with the button controls for the two virtual looping devices. So when you see “Rec 1” boxed-in on the score that means to click “Rec 1” on the patch.

What Else Can You Do?

Try changing the repeats in the score or even going back to other parts of the score to create different layers. What would happen if you let the loops fade out and then you started playing in a different key? Improvise lines and extend the “pulses” in the score!

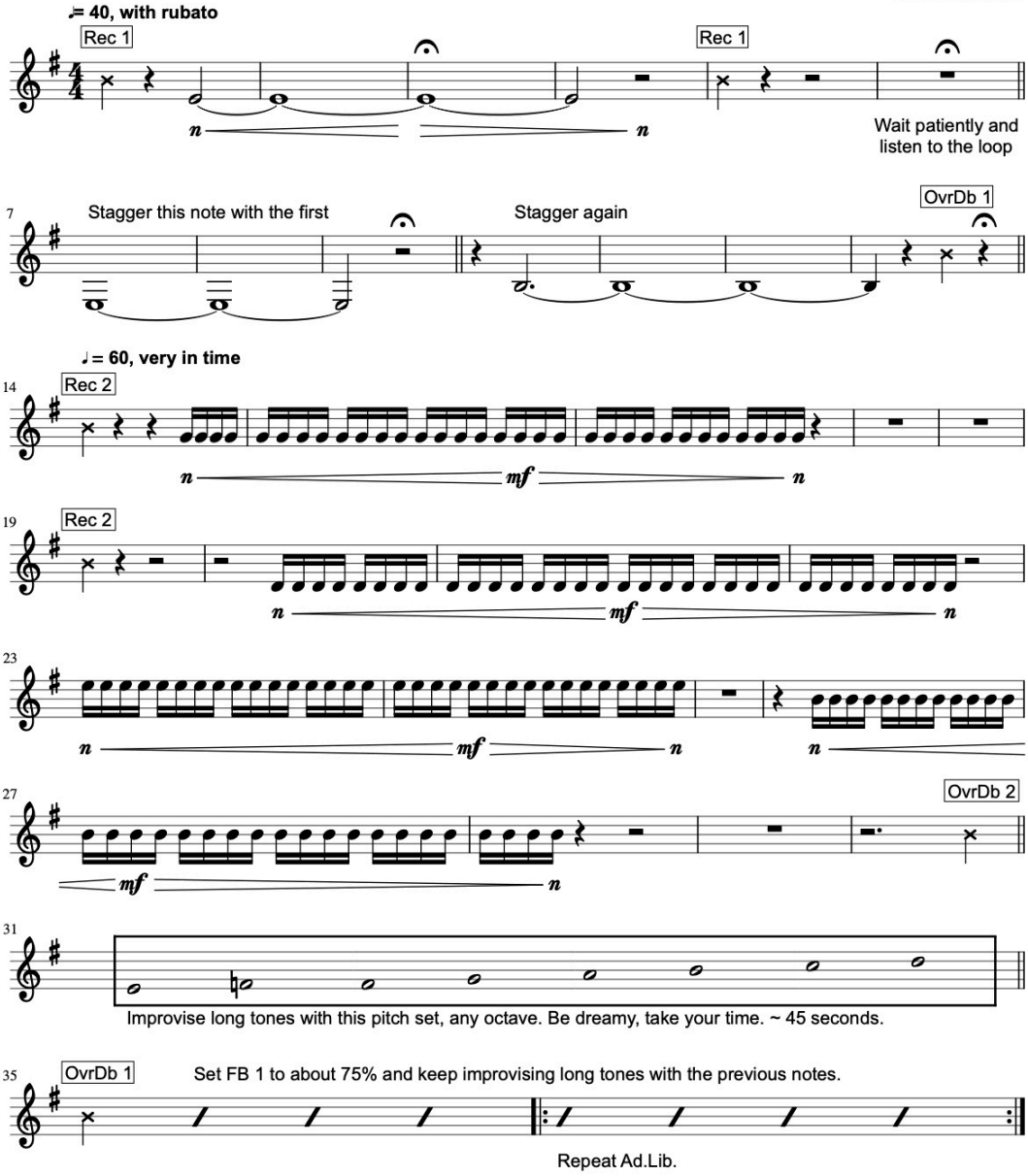
Further Listening

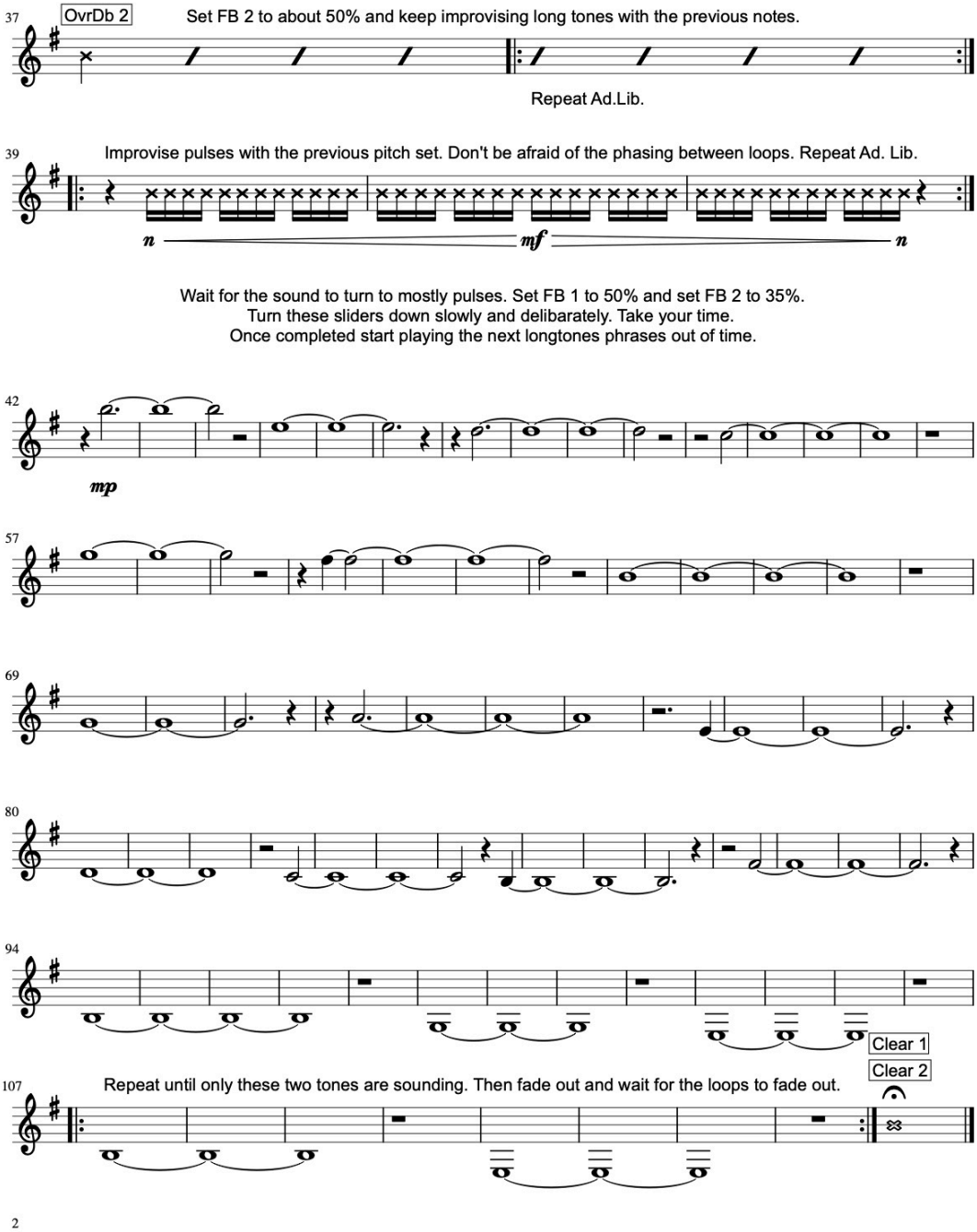
Some of Terry Riley’s early experiments with tape loops yielded some really beautiful soundscapes. Click the following link to see a live set by Terry Riley in 1977: https://www.youtube.com/watch?v=ZfHmEblM1Dk. One of the inspirations for this piece was the work of Steve Reich who created several “phase” pieces including *Come Out*. *Come Out* uses several different tape recordings of the same phrase (“Come out to show them”) first played in unison and then gradually moving “out of phase” with each iteration. Click the following link to see a choreographed performance of “Come Out”: https://www.youtube.com/watch?v=ouYiTiiY3vg.

Recurrence

an electroacoustic etude for clarinet and loopers

Josh Bennett




37
OvrDb 2
Set FB 2 to about 50% and keep improvising long tones with the previous notes.
Repeat Ad.Lib.
39
Improvise pulses with the previous pitch set. Don't be afraid of the phasing between loops. Repeat Ad. Lib.
n
mf
n
Wait for the sound to turn to mostly pulses. Set FB 1 to 50% and set FB 2 to 35%.
Turn these sliders down slowly and delibarately. Take your time.
Once completed start playing the next longtones phrases out of time.
42
mp
57
69
80
94
Clear 1
Clear 2
107
Repeat until only these two tones are sounding. Then fade out and wait for the loops to fade out.

6.8 “Enter. Play.”

Enter. Play.

an electroacoustic etude for clarinet and sequencer

What is a Sequencer?

In synthesized music a sequencer is a device that plays a predetermined sequence of notes. This sequence can then be used to control a synthesizer. In *Enter. Play.* our sequencer and synthesizer are built into a single patch and are automated by the programming. In this sense, *Enter. Play.* is a piece of “fixed media” where the accompaniment is predetermined. In other words: your job is to read the music and the synthesizer will take care of the rest!

Getting Set Up

The set up for this etude is very simple. Turn on audio with the green button, and then click Start. Technically you don’t *need* to amplify your instrument. However, there is an option to amplify your instrument in the right-hand mix controls if you so choose.[1] That’s it! Everything else should be automated.

What Else Can You Do?

Practicing with fixed media can often be difficult. The computer, afterall, will not respond to you! So you may want to slow the synthesizer part down. Use the sequencer controls on the bottom of the patch to change the tempo to help with your practice. If you feel comfortable with the piece try experimenting with the sequencer controls on your own. Click the “Mess Around” button and you should be able to play with all the faders, number boxes, and toggles. Try making some of your own sequences and play along with those.

Further Listening

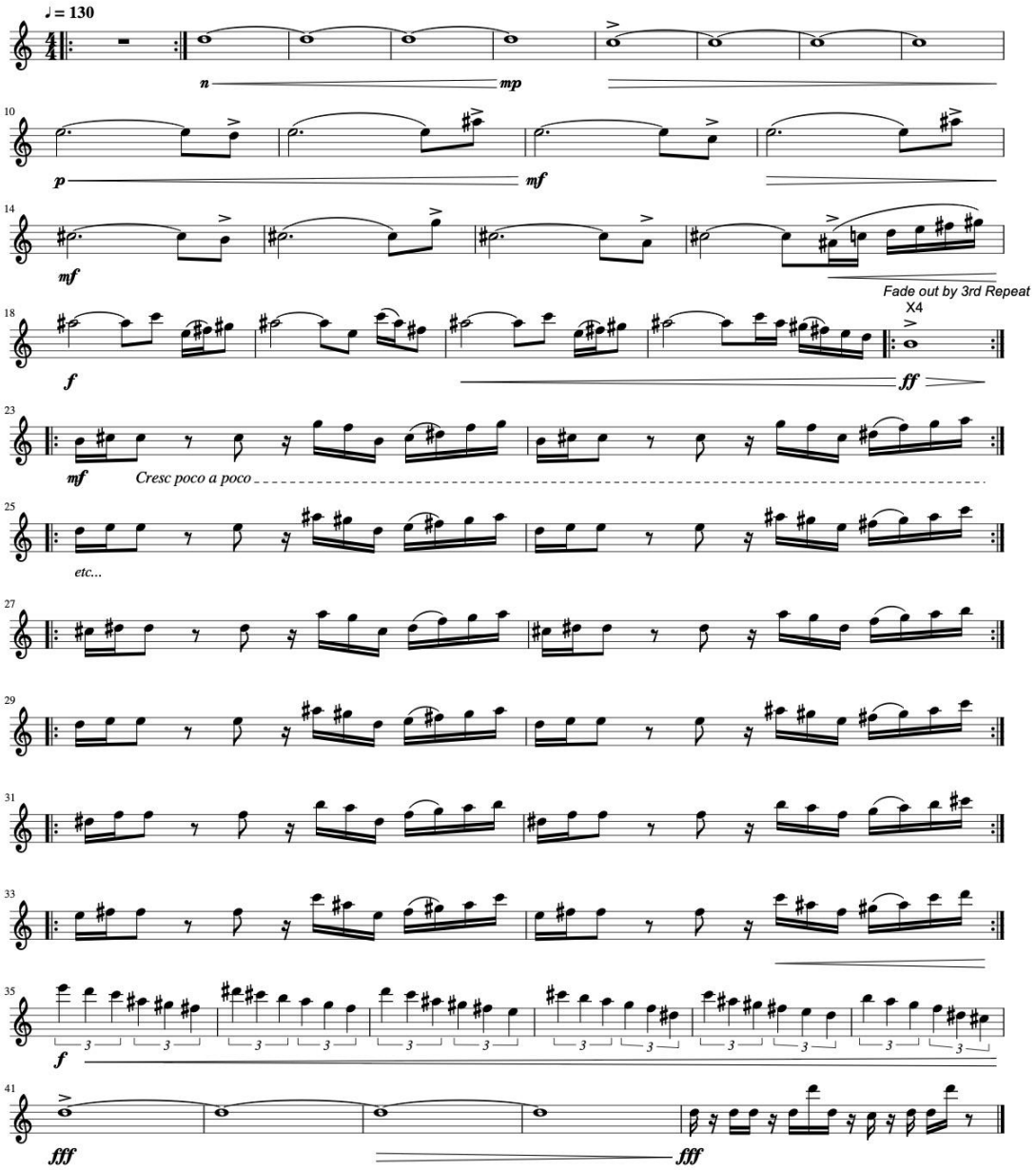
One of my favorite synth composers that pioneered the use of sequencers is Lauri Spiegel. Her album, *The Ever Expanding Universe,* has several works that take full advantage of sequencers and synthesizers to produce some truly astonishing music. Here’s a link to *Appalachian Grove I*: https://www.youtube.com/watch?v=TFaUAAj0ubg. There are also several bands that use a lot of sequencers such as Kraftwerk, Tangerine Dream, and S U R V I V E.

[1] I recommend amplifying your instrument if only to help with proper balance. Experiment with your equipment and the space you are performing in, however, to determine if it is necessary.

Enter. Play.

An electroacoustic etude for Clarinet and Pure Data

Josh Bennett



6.9 “A Man From Mars”

A Man From Mars

an electroacoustic etude for clarinet and fixed media

What is fixed media?

Any time you play along to a “backing track” or “tape” you are playing along to fixed media. Once upon a time electroacoustic music was almost always a kind of fixed media since you could only reproduce electronic sounds on magnetic tape. Today we have several options beyond magnetic tape. In this case I utilized Ableton to create a backing track that you play along to with the score provided.

Getting Set Up

Set up is very straightforward and easy for this etude. Turn on audio with the green button at the top, set your volume levels, and then click on the button for the version of the backing track you want to play along with. There are two versions of the track that include “click tracks” to help with practice. One is at 140 bpm and the other is at 160. Then there’s the track without a click at 180 bpm that you would use for performance. Input on this etude is optional but I do recommend “plugging in” for live performance if only for balance. That decision, however, I leave to you.

What Else Can You Do?

Who said you have to play what I wrote? During the solo section you can try an improvised solo instead of the written solo. Or if you want - write your own melody and play along with that! I’d love to hear what you come up with.

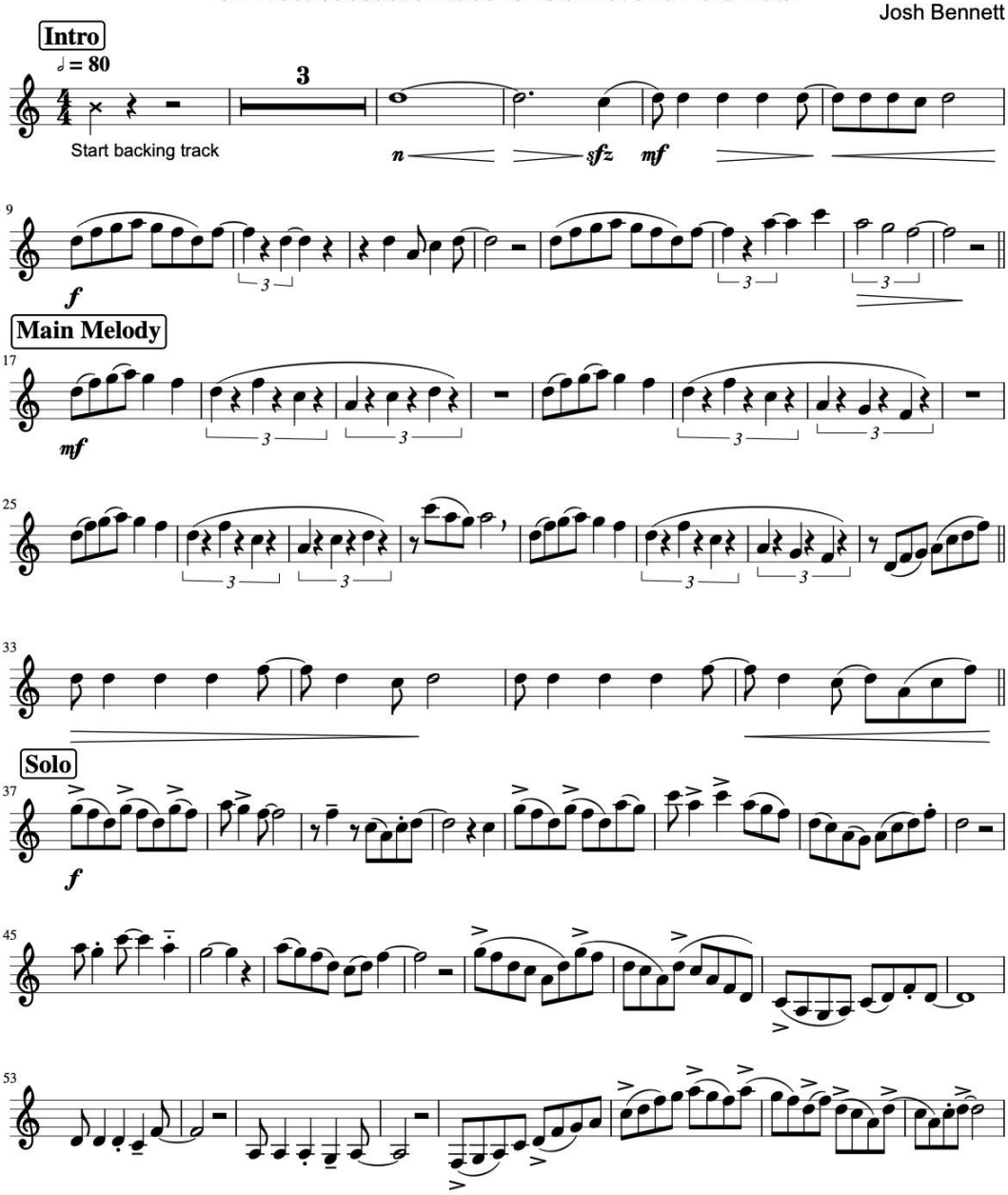
Further Listening

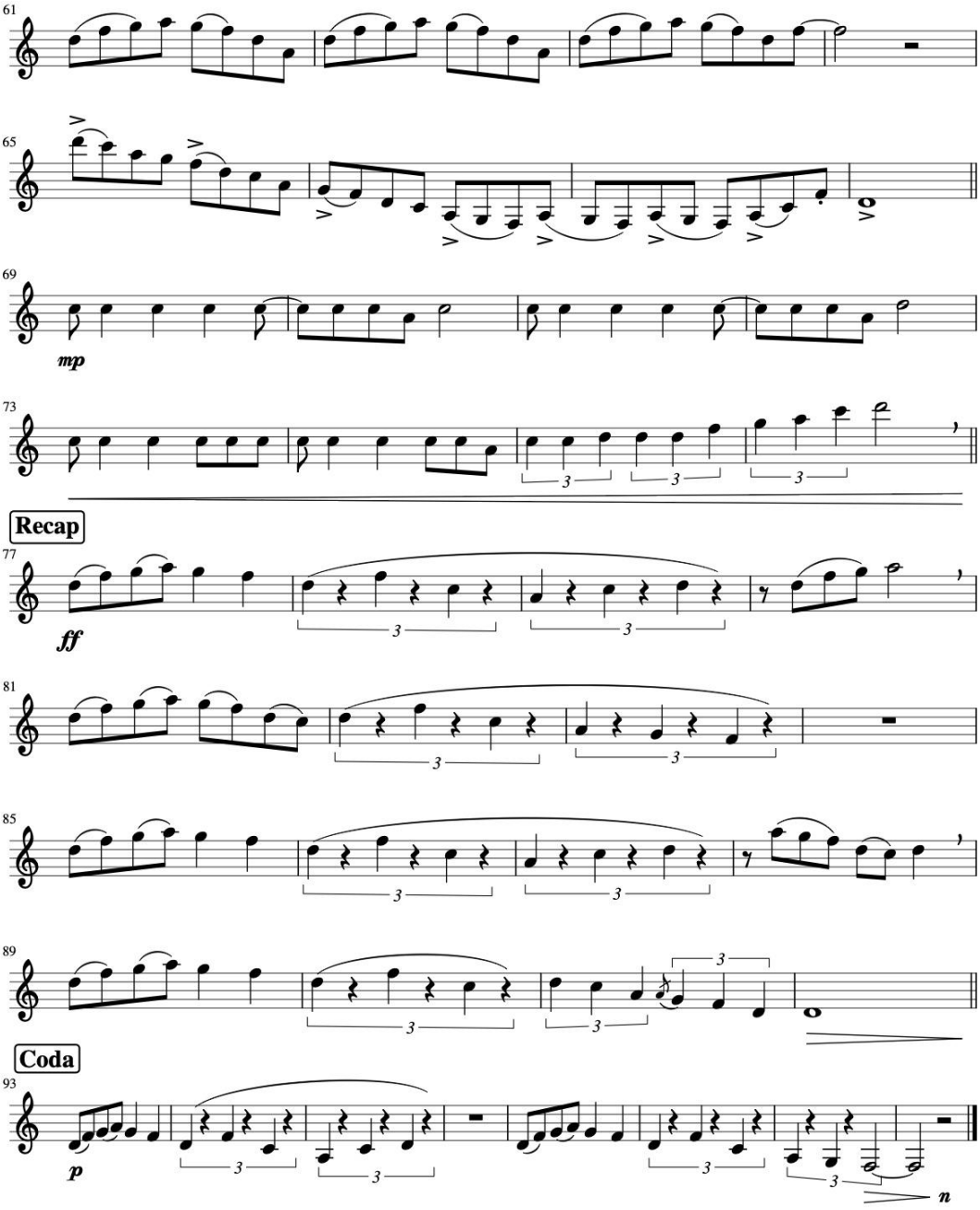
There are numerous works for clarinet and fixed media. Older “tape” pieces such as “Composition for Clarinet and Tape” by David Olan (https://www.youtube.com/watch?v=__L-HQYtqVw) or William O. Smith’s “Sumi-E” (https://www.youtube.com/watch?v=9b6UDsu0mIU) are great examples. Alexey Gorokholinsky (who goes by the moniker Kronodigger) makes excellent modern clarinet + fixed media pieces that you can buy on his bandcamp page: https://kronodigger.bandcamp.com/.

A Man From Mars

an Electroacoustic Etude for Clarinet and Pure Data

Josh Bennett




61
65
69
mp
73
Recap
77
ff
81
85
89
Coda
93
p
n
2

6.10 “A Grain of Truth”

A Grain of Truth

an electroacoustic etude for clarinet and granular delay

What is Granular Delay?

Granular synthesis is a form of sound synthesis where sound is split into very, very, very small sections (often less than 50 milliseconds long!) A Granular delay, then, is a device that takes live sound, splits it into millions of little fragments, or “samples”, and reconstructs those samples a little later. The reconstruction is purposefully imperfect and results in a “sparkly”, digitized sound. Further, this reconstruction allows the computer to change and process the pitch or speed of your live sound.

Getting Set Up

The piece requires you to interact with your computer by pressing specific number keys at places indicated in the score. So, make sure your computer is close at hand. I like to set my computer up just to the right of my music stand. Double check your input/output settings in Pd and click the “Turn On” button to start audio. Then adjust both the “Input” and “Master” sliders to get a mix you are happy with. Begin playing the piece and press the number keys on your computer where indicated to manipulate the sound processing.

What Else Can You Do?

Who said you *have* to hit the number keys in the right order? Experiment with different number key sequences to see what happens. A fun exercise would be to play the etude but *only* use the number 5 “Rando” key. Then each time you play the etude it will be different and randomized!

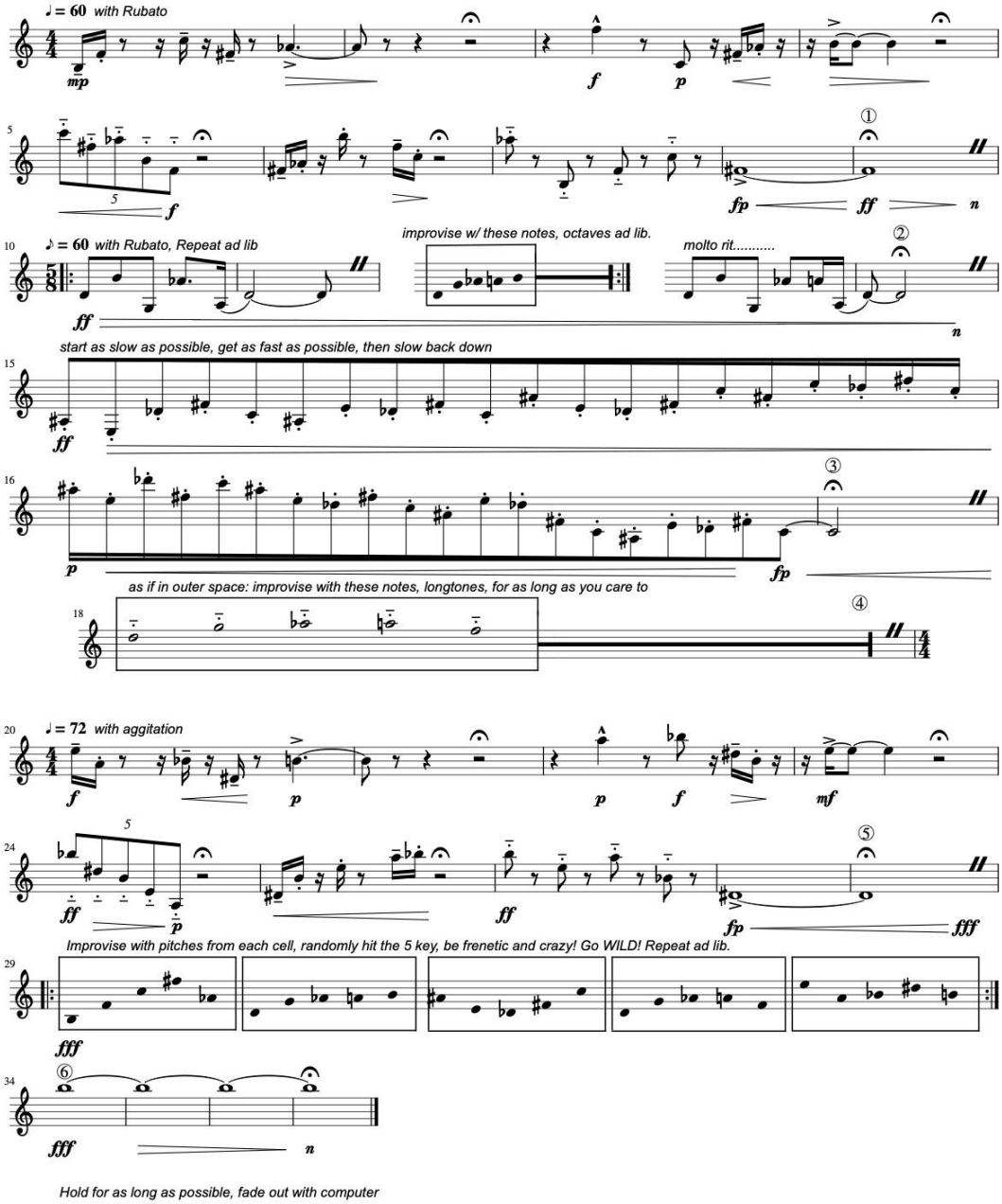
Further Listening

Curtis Roads is a pioneer of granular synthesis and sound and his piece *Half Life* from 1999 is an excellent example. The british electronic group The Prodigy also utilized a lot of “microsounds” and pitch bending/sampling including their hit song “Firestarter”. You can see the music video for “Firestarter” here: https://www.youtube.com/watch?v=wmin5WkOuPw.

A Grain of Truth

an etude for clarinet and Pure Data

Josh Bennett



6.11 “Flutter & Shift”

Flutter & Shift

an electroacoustic etude for clarinet and amplitude/frequency modulation

What is Modulation?

In electronic music modulation is when there is a change to the sound being produced. Frequency Modulation (FM) manipulates the incoming pitch while Amplitude Modulation (AM) manipulates the dynamics of an incoming sound. In this case both your frequency and pitch will be modulated by different degrees during the performance of this piece. Some of the modulation may appear subtle, at first, but as the modulation increases new and interesting timbres will begin to emerge based on your live sound.

Getting Set Up

The setup for this piece is relatively easy but there are a few things you need to be aware of. Turn on audio with the green button in the upper left and adjust the input and master output sliders as needed. You will need to make sure you can see the computer’s screen because the built-in timer on the patch is critical to an accurate performance. I like to have my computer set up just to the right of my music stand for a clear view. Once you are set up click the “Start” button and begin playing the piece. The patch’s parameters are automated so all you have to do is follow the time markings in the score.

What Else Can You Do?

If you click the “Reset” button and *don’t* click the “Start” button you can manipulate all of the sliders, boxes, and numbers on this patch. Experiment by turning up the AM volume and increase the “AM Freq” box by clicking and dragging. At what frequency does the amplitude modulation change from a vibrato to producing a new pitch?

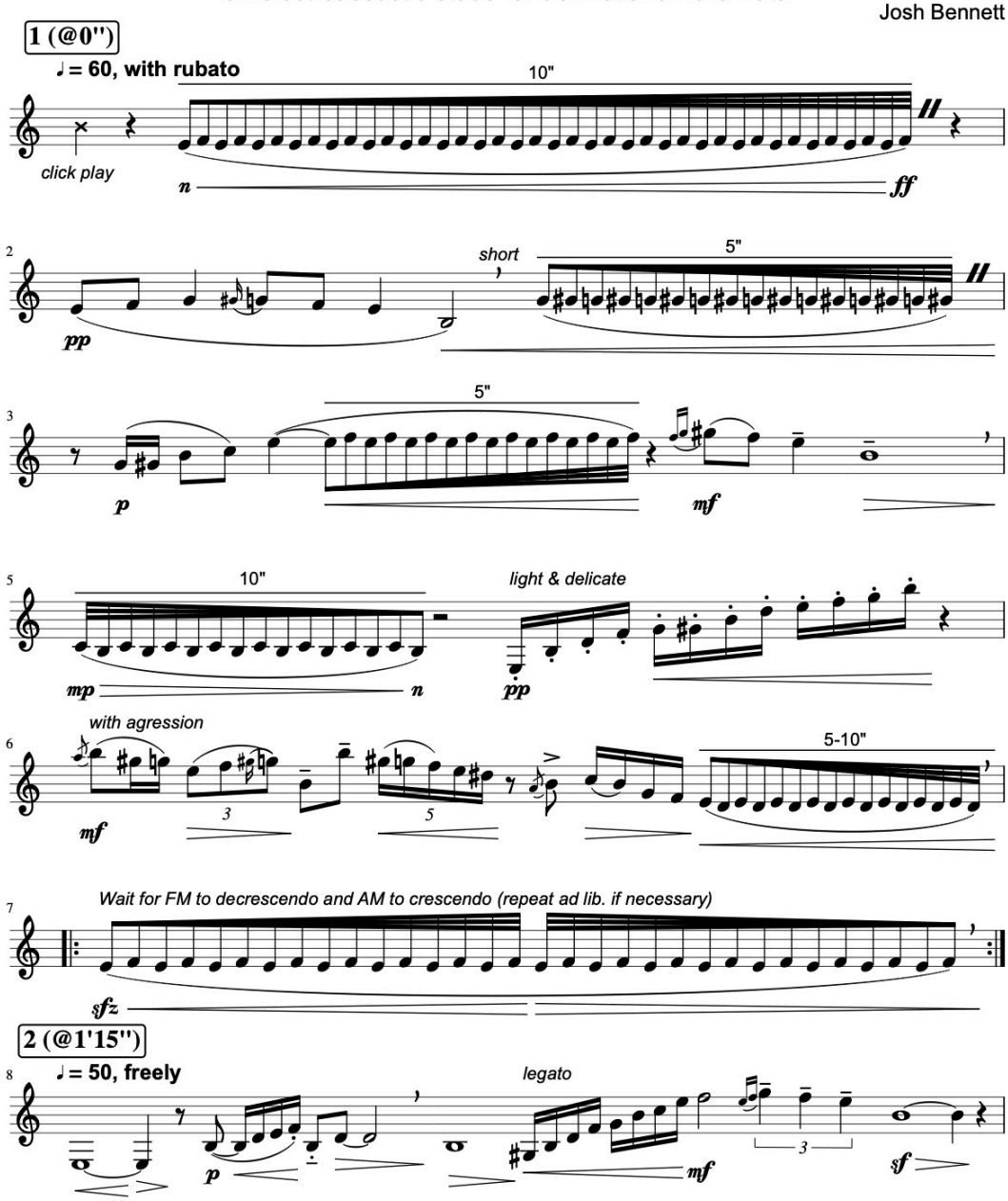
Further Listening

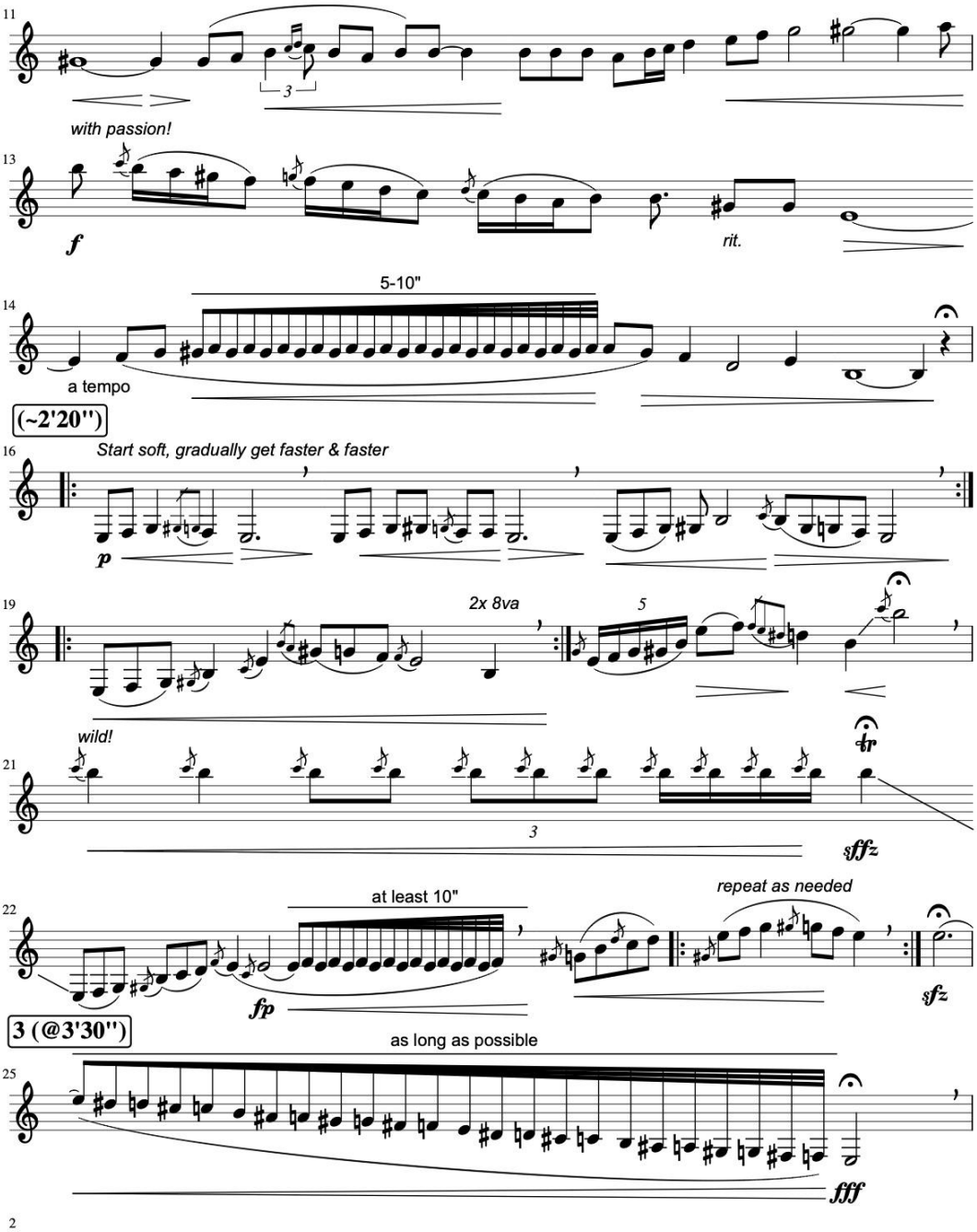
This piece is an homage to one of my favorite electroacoustic works for clarinet: *Passages of the Beast* by Morton Subotnick. Subotnick was a pioneer of “interactive” electronic music and this monumental work was proof of just how effective manipulating and changing live performance could be. You can find several recordings of *Passages of the Beast* online via YouTube or Spotify. If you like this kind of music and want to learn more go to Subotnick’s website for more information: http://www.mortonsubotnick.com/.

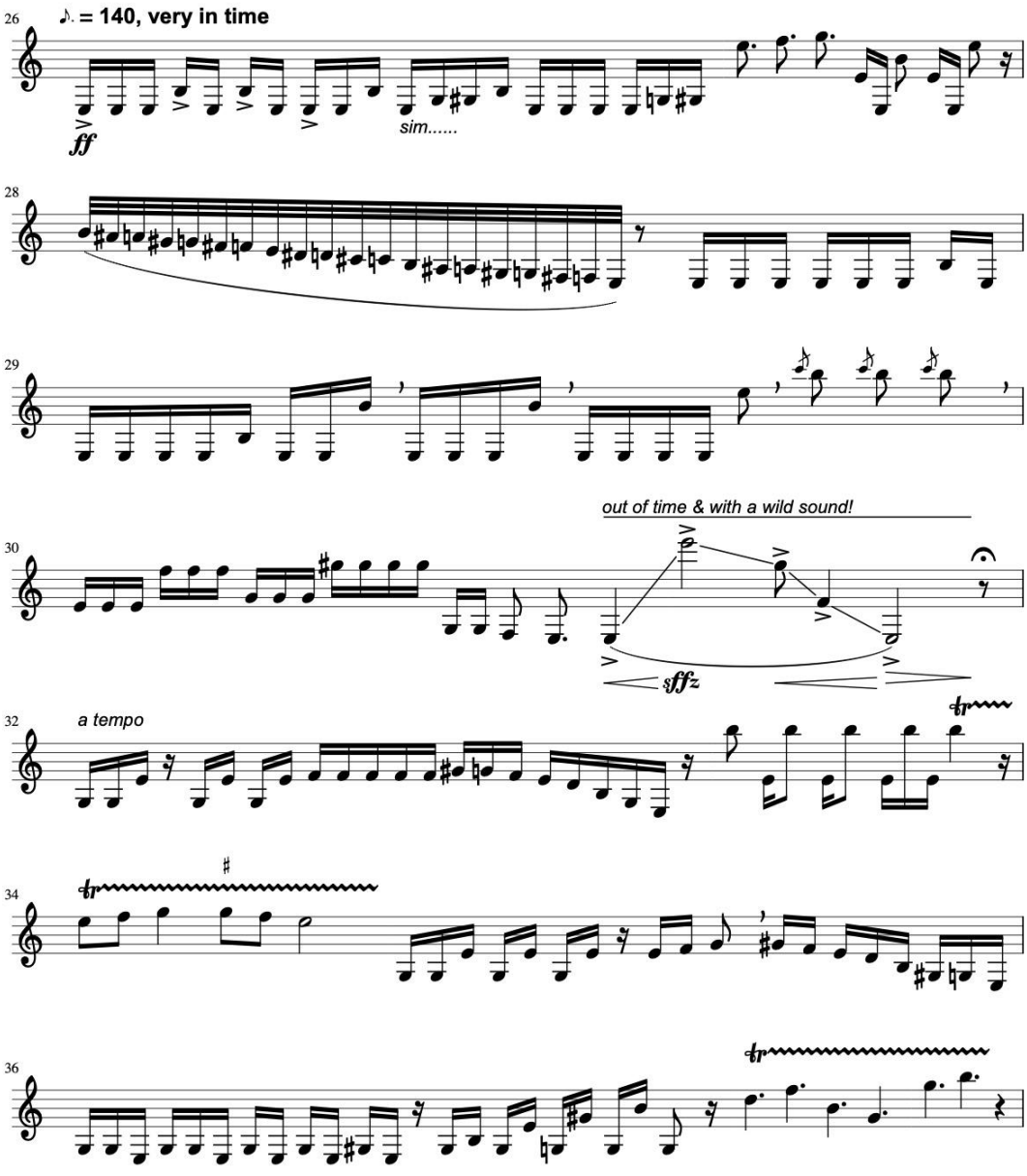
Flutter & Shift

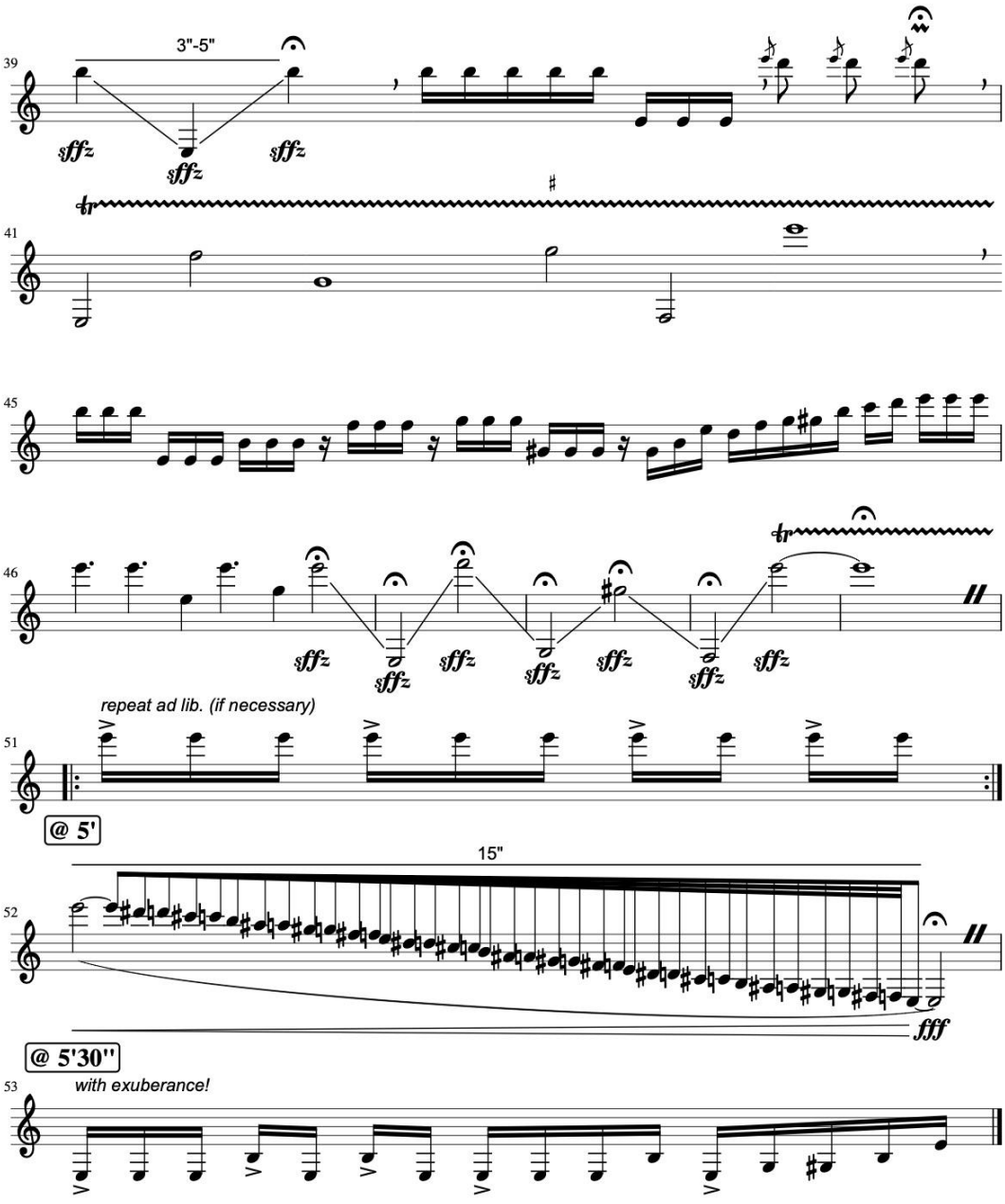
an electroacoustic etude for clarinet and Pure Data

Josh Bennett




11
3
with passion!
13
f
rit.
5-10"
14
a tempo
(~2'20")
16
Start soft, gradually get faster & faster
p
19
2x 8va
5
wild!
21
3
sffz
at least 10"
repeat as needed
22
fp
sfz
3 (@3'30")
as long as possible
25
fff
2


26
♪. = 140, very in time
ff
sim.....
28
29
out of time & with a wild sound!
30
sffz
32
a tempo
34
36


39
3"-5"
sffz
41
45
46
repeat ad lib. (if necessary)
51
@ 5'
15"
52
fff
@ 5'30"
53
with exuberance!

4

6.12 Conclusion

Recently, a student of mine at Rosie's House (a local non-profit music academy) asked me the question, "How can I do that?" after I played an electroacoustic piece for her. As mentioned in the introduction, when faced with this question in the past, I simply would not have an answer. This time, however, I was able to give my student two of my *Electroacoustic Etudes*. We worked on "Loop Da Loop" and "Moving Through Space/Time" as she was preparing for an end-of-year recital. Together we learned how to operate the patches, learned about signal flow, discussed input and output, and figured out how best to fully utilize the available effects with her instrument. It was exciting, fulfilling, and above all else, fun.

Each of the preceding etudes and corresponding patches were created with one ultimate goal: create electronic music for the clarinet that is both engaging and exciting. A variety of influences were combined to create the etudes, including literature by experts like Miller Puckette, Jon Appleton, and Johannes Kreidler, music by great composers/performers like Morton Subotnick, Michael Lowenstern, and Zoë Keating, and personal experience. Working with several students and colleagues throughout my time as a musician has taught me that there is an interest in electronic music, but many people simply do not know where to start. It is my hope that the *Electroacoustic Etudes* will help alleviate the fears and prohibitions that are often associated with learning electronic music. Electronic music *is* the music of now. Electronic music is also extremely exciting and can ignite significant creative potential in both composers and performers alike. By writing (and performing) the *Electroacoustic Etudes*, it is my hope that generations of clarinetists will join the continuing electronic revolution and see Puckette's dream of a thriving creative force come to fruition.

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BIOGRAPHICAL SKETCH

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